UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF TEXAS
WACO DIVISION

JENS H. S. NYGAARD

Plaintiff,

v.

FÉDÉRATION INTERNATIONALE DE L'AUTOMOBILE, FORMULA ONE MANAGEMENT LTD., DELTA TOPCO LTD., MERCEDES-BENZ GRAND PRIX LTD., RED BULL TECHNOLOGY LTD., RED BULL RACING LTD., FERRARI S.P.A., SCUDERIA FERRARI S.P.A., DALLARA AUTOMOBILI S.P.A.

Defendants.

Case No.: 6:20-cv-00234

JURY TRIAL DEMANDED

ORIGINAL COMPLAINT FOR PATENT INFRINGEMENT

I. INTRODUCTION

1. Plaintiff Jens H. S. Nygaard ("Nygaard") files this Complaint for infringement of his United States Patent No. **7,494,178** ("the '178 patent") in violation of Sections 271(a), (b), (c) and (f) of Title 35 of the United States Code, by Fédération Internationale de l'Automobile ("FIA"), Formula One Management Ltd. ("F1"), Delta Topco Ltd. ("Delta"), Mercedes-Benz Grand Prix Ltd. ("Mercedes"), Red Bull Technology Ltd. ("RBT"), Red Bull Racing Ltd. ("RBR"), Ferrari S.p.A. and Scuderia Ferrari S.p.A. (collectively "Ferrari"), and Dallara Automobili S.p.A. ("Dallara") (collectively "Defendants"), by making, using, selling, importing and exporting the "Halo" and "Aeroscreen" devices in the United States for implementation in cars in the United States, and/or use of cars implementing Halo and Aeroscreen and/or indirectly causing others to do so, as well as supplying their components, including components with no

substantial non-infringing use, for export.[1] The Halo has been implemented to protect the heads and necks of drivers in the U.S. Grand Prix, U.S. ePrix, and Formula 3 and 4 events in the United States. The Aeroscreen has been implemented for the same purpose in IndyCar Events in the United States. A copy of the '178 patent is attached.

2. The Halo was developed from Mr. Nygaard's patented technology, after meetings among him, FIA, Mercedes and Dallara in late 2012 and the spring of 2013.[2]

3. Despite Mr. Nygaard's personal involvement in developing the Halo, and their knowledge of his patent rights, the Defendants have never taken a license or paid him a royalty.

4. FIA describes itself as "the governing body for world motor sport and the federation of the world's leading motoring organisations." It is a non-profit making association based in France. It is a membership organization under French law.[3] FIA regulates the U.S. Grand Prix held at the Circuit of the Americas in Dell Valle, Travis County, Texas ("COTA") and the U.S. ePrix on New York City roads. FIA also regulates Formula 3 and Formula 4 racing at COTA, and other places in the U.S.

5. F1 is the entity that manages and commercializes Formula One Grand Prix racing. It is an indirect subsidiary of Liberty Media Corporation ("Liberty"). F1 is a successor in interest to the original Formula One company founded by Bernie Ecclestone.

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[1] In light of the worldwide Covid-19 ("corona virus") pandemic, Mr. Nygaard is filing contemporaneously with his complaint an ex parte motion proposing measures for the initial phase of this case to accommodate the burden our society, the courts, and all of us are now dealing with, so as to protect everyone's rights without prejudicing anyone.

[2] The FIA and FIA Institute for Motor Sport Safety and Sustainability ("FIA Institute") worked with Mr. Nygaard from late 2012 through about the first quarter of 2013. FIA was involved in the FIA Institute's work at all relevant times, and took over the Project completely in 2017 after FIA Institute closed at the end of 2016.

[3] FIA formed the FIA Foundation in 2001 as its charitable arm, and these organizations formed the FIA Institute for Motor Sport Safety and Sustainability in 2004. The FIA Institute for Motor Sport Safety and Sustainability ceased programs and projects as of December 31, 2016. As of January 1, 2017, the FIA Institute's work was divided between the Global Institute for Motor Sport Safety and the FIA.

6. Delta was established through the efforts of Bernie Ecclestone, it is the entity that owns the license from FIA to exploit rights regarding the Formula One Grand Prix series. It is an indirect subsidiary of Liberty.

7. Mercedes is the racing arm of Mercedes-Benz and its parent Daimler AG. It has teams that competed in the 2018 and 2019 U.S. Grand Prix and the 2019 U.S. ePrix events with cars implementing the Halo. Mercedes engineering met with Mr. Nygaard in 2013 at FIA headquarters in Paris as part of the project that developed the Halo.

8. Ferrari is a manufacturer of automobiles, races in Formula One Grand Prix events and operates the Ferrari Driver Academy to train Formula Circuit drivers. Scuderia Ferrari is its racing team, and competed in the 2018 and 2019 U.S. Grand Prix events with cars implementing Halo. It is a licensor of its brand and trademarks, which constitutes a large part of its business.

9. RBT is a technology company for the automobile industry and also owns and operates RBR. RBT is an indirect subsidiary of Red Bull GmbH. RBT developed the original Aeroscreen during the FIA process resulting in adoption of the Halo. RBT and Dallara supply Aeroscreen to the U.S. for implementation in cars competing in IndyCar Circuits.

10. RBR is owned by RBT. It has a team competing in the Formula One Grand Prix series. In 2018 and 2019, RBR had a "sister team" also owned indirectly by Red Bull GmbH, or sometimes called its "junior team," Scuderia Alpha Tauri, formerly called Scuderia Torro Rosso (owned by a different Red Bull entity), which also competed in the same Formula One Grand Prix events. Both teams competed in the 2018 and 2019 U.S. Grand Prix in cars implementing Halo.

11. Dallara is an Italian manufacturer and assembler of automobile chassis, upgrade and safety kits, as well as parts, for various motor racing series, including Formula e, Formula 3, Formula 4, and IndyCar Circuits, among others. Dallara engineering met with Mr. Nygaard in

2013 at FIA headquarters in Paris as part of the project that resulted in Halo being chosen by FIA for driver safety in July 2017. Dallara collaborated with Red Bull on the Aeroscreen and supplies Aeroscreen components to U.S. IndyCar teams.

12. Defendants are liable for damages to Mr. Nygaard for direct and indirect infringement, literally or by equivalents, at COTA in Travis County, Texas, among other places. Defendants' infringement has been knowing and willful. This is an exceptional case because the Defendants have long known they were infringing the '178 patent, but exploited Mr. Nygaard's patent for their own profit in disregard of his rights. Accordingly, each Defendant is liable for his actual damages, trebled, and his attorneys' fees, pre and post-judgment interest, expenses and costs.

II. FACTUAL BACKGROUND

13. On March 29, 2004, Mr. Nygaard's original patent application for his inventions for vehicle safety was filed in Great Britain. Among other things, Mr. Nygaard's inventions protect people from accidents caused by collisions, flying objects, and roll-overs.

14. The original application, subsequent filings in the U.S. Patent and Trademark Office ("USPTO"), filings in other jurisdictions and the issued '178 patent itself, included drawings that illustrated many examples of embodiments of his inventions, including cars with what Defendants now refer to as the "Halo." The Aeroscreen is essentially a "jet cockpit" windscreen combined with a Halo.

15. Shown below from left to right are figure 68 from the '178 patent, a depiction from FIA regulations of the Halo, and the Halo of the car driven by Charles LeClerc in the 2018 Belgium Grand Prix. The marks on the Halo of Mr. LeClerc's car were caused by the tire of another F1 car

that launched into the air in a multi-car accident during the race. The Halo received worldwide praise for saving Mr. LeClerc's life.

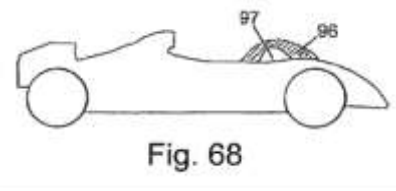
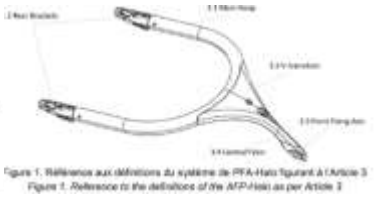


Fig. 68



16. Mr. Nygaard contacted manufacturers, government regulators, FIA, Delta, F1 and others in the automobile industry to improve safety with his patent pending inventions. He reached out to the FIA by 2005 to improve safety in motor sports. He discussed his inventions, and also consulted with, major car manufacturers, government and others in the automobile industry. Mr. Nygaard directly contacted Mr. Bernie Ecclestone of Delta and Formula One in 2006 about his patent applications to bring his safety inventions to Formula One.

17. For years, Mr. Nygaard brought his patent applications, patents and inventions for safety to automobile manufacturers and others in the industry through correspondence, consultations, presentations and discussions. Upon information and belief, Mr. Nygaard believes that through his correspondence and meetings with FIA and the FIA Institute, as well as his efforts to present his safety innovations to industry, his patents were known to Defendants before infringement of the '178 patent in this country.[4]

[4] Further, in June 2018, Ferrari filed for an Italian patent on its Halo design. During prosecution of its patent application in the European Patent Office, the examiner cited the Nygaard European patent application as prior art against Ferrari' application. Ferrari filed for a U.S. Patent on June 7, 2019 and cited as prior art Mr. Nygaard's European patent application. The U.S. application published on December 12, 2019. The motor sport press quickly picked up on the published application and it was widely publicized in December 2019.

18. At all relevant times, Delta has held and continues to hold the license from FIA to commercialize the Grand Prix series, including media rights. Delta's license was first commercialized by the original Formula One company run by Bernie Ecclestone. Liberty Media Company acquired the Delta and the Grand Prix/Formula One business in 2016. Formula One Management Ltd. is the "Liberty entity" that runs Grand Prix/Formula One commercial operations.[5]

19. Despite Mr. Nygaard's call for improved driver safety in 2005 and 2006, FIA and F1 declined to discuss his inventions with him at that time. But in 2009, Driver Henry Surtees died driving in a 2009 Formula 2 event when he was struck in the head by flying debris. Had Mr. Nygaard's inventions been deployed when he brought them to the attention of FIA and F1, Mr. Surtees might still be driving. (Driver Felipe Massa suffered a head injury when he was hit by flying debris in the 2008 F1 Hungarian Grand Prix, and Mr. Nygaard's inventions very likely would have spared him from injury.) After Mr. Surtees' untimely death, FIA focused on finding a solution for protection of the heads and necks of drivers, which became a safety project that extended at least until 2017 (hereinafter the "Project").

20. Driver head and neck safety also came under scrutiny in other open cockpit racing. FIA also administers the World Endurance Circuit, sometimes called Le Mans racing. By 2016 FIA banned open cockpit racing in the World Endurance Circuit.

[5] The contracts between Delta and FIA and also between FIA and its member teams, as well as contracts between F1 and Delta, are not publicly available. Any contracts between any Liberty Media Company or Delta or F1 and/or any of their subsidiaries and affiliates regarding Formula racing or any Grand Prix race or team are not publicly available. Since Plaintiff has no access to any of these contracts, Plaintiff will amend if needed on relevant issues, if any.

21. FIA conducted a series of tests on different devices for driver head and neck protection in 2011. The testing showed the devices FIA had studied were not suitable for its purposes.

22. In 2011, Dennis Wheldon, a popular driver who competed in IndyCar, Daytona Endurance and other racing, was killed. Dennis Wheldon died in an accident during the championship race of the IndyCar season on October 16, 2011, at the Las Vegas Motor Speedway. Dennis Wheldon's death heightened the urgency of, and further demonstrated the need for, the Project. Dallara named its 2012 model chassis in his honor, which is known as the Dallara DW12.

23. In or around 2011, IndyCar began investigating improvements for driver safety. IndyCar had monitored, and also provided data, for the FIA Project.

24. Having failed in its attempts to find a suitable safety device, in late 2012, FIA met with Mr. Nygaard to consult on the Project. In early 2013, Mr. Nygaard met with Mercedes, Dallara, and FIA to implement his inventions for Formula racing.

25. In July 2017, the Project culminated in the adoption by FIA of the "Halo". The Halo infringes Mr. Nygaard's '178 patent.

26. Dallara made the chassis for IndyCars (DW12), and kits for those chassis to improve aerodynamics and safety, among other things. The DW12 chassis is also used for Formula e, Formula 2, 3 and 4 as well as other Formula cars. Dallara manufactured equipment to implement the Halo in Formula e, Formula 2, Formula 3, Formula 4, and other Formula cars. Dallara made and supplied kits to modify the DW12 chassis for addition of the Aeroscreen to Indy Series cars.

27. Mr. Nygaard's '178 patent was issued in 2009. FIA knew of Mr. Nygaard's patent rights before he met with FIA in late 2012. Mr. Nygaard made an offer to license his patents to FIA in the spring of 2013. At a meeting at the FIA Institute in London at or around that time, FIA

insisted that he waive his patent rights for the Project. Mr. Nygaard refused. FIA later rejected Mr. Nygaard's offer at the end of May 2013, and did not extend a counter-offer. The FIA's letter expressly acknowledged there was no license. FIA went on to say negotiations must be conditioned on the agreement that he would not receive any compensation whatsoever, until and unless the FIA successfully commercialized his patents in the future, gave FIA exclusive control over his patents for motor sports, along with other onerous terms. Mr. Nygaard refused the FIA's conditions to commence negotiations.

28. Mercedes and Dallara also knew about Mr. Nygaard's patents from dealing with him and FIA in the Project. Further, upon information and belief, other F1 teams learned of Mr. Nygaard's patents either through his past efforts, the FIA's work with Mr. Nygaard, and/or the licensing issue. Upon information and belief, RBT and RBR learned of Mr. Nygaard's patents by this time, and no later than 2016 when it was testing the Aeroscreen.

29. In 2014, Jules Bianchi suffered mortal head and neck injuries in an accident at the 2014 Formula 1 Japanese Grand Prix, and later died in 2015. In 2015, driver Justin Wilson died of head and neck injuries in an IndyCar race at the Pocono Motor Speedway.

30. In December 2015 and July 2016, the Grand Prix Drivers' Association Ltd. ("GPDA") petitioned for improved driver safety protection. In 2015, elements of the F1 Grand Prix series fan base and press were urging F1 and FIA to take measures to prevent any more driver deaths.

31. Mercedes showed its prototype Halo in 2015. RBT and RBR reconfigured the Halo by taking out the center pillar, replacing it with pillars on each side of the driver, and adding a windscreen made of "jet fighter" glass. They called this device the Aeroscreen and submitted it

for consideration for the Project. They demonstrated the Aeroscreen in F1 events around the May 1, 2016 Russian F1 Grand Prix.

32. By summer 2016, it appeared FIA would adopt the Halo for its 2017 season. This prompted a strong negative reaction from a large number of fans, many in the motor sport press, and many teams. In response, FIA committed to delay choice of a new driver safety device for one year to continue to test and seek out options other than the Halo.

33. FIA later arrived at a concept called the "shield", which was made out of "jet fighter glass" and bent around the driver leaving an opening at the top. Ferrari agreed to further develop and test the "shield". Ferrari tested the "shield" on an F1 car on July 14, 2017 at Silverstone during British Grand Prix events. Sebastian Vettel was the driver for the test. Kettel, however, aborted the test after one lap reporting that the curvature of the shield made it difficult to see, especially when looking forward. He also reported the shield made him dizzy. Although the shield was scheduled for another test in September 2017 at the Italian Grand Prix, that plan was aborted after the unsuccessful run in England.

34. About two weeks later, at a press conference in late July 2017, FIA made a presentation where it detailed its analysis of the best options for driver safety. The presentation compared the Halo with the original Aeroscreen, as well as a potential "closed cockpit" or shield design. FIA announced Halo was the only improvement that passed all of its tests, and would be implemented in Formula circuits starting in the 2018 season (https://youtu.be/AYkGjUHstKY).

35. Halo was implemented in the F1 Grand Prix Circuit in 2018, and all Formula circuits by 2019. All vehicles competing in the 2018 and 2019 U.S. Grand Prix at COTA and in the 2019 ePrix on New York City roads implemented the Halo. Likewise, these vehicles and their components, including components with no substantial non-infringing use, were supplied from the

U.S. to other countries following the U.S. Grand Prix events. About nine teams also supplied their vehicles and components, including components with no substantial non-infringing use, to other countries following the 2019 U.S. ePrix events. Moreover, the U.S. F1 team, Haas Racing LLC, was required by FIA and F1 to implement Halo on its U.S. based F1 cars. Upon information and belief, Haas Racing LLC drove open cockpit vehicles implementing the inventions on roads in or near its facility in the U.S.[6] There are three U.S. based Formula e teams, which were all required to implement Halo on their cars for the 2019 U.S. ePrix. Upon information and belief, all three teams implemented the Halo in the U.S. on their Formula e cars and tested their vehicles on roads in or near their facilities. The same is true for U.S. teams competing in U.S. Formula 3 and Formula 4 Circuit events.

36. Since Halo's adoption in July 2017, FIA was also active in the production and testing of all Halos used in F1, F2 and Formula e events. FIA designated approved manufacturers for the Halo, and required Halo for F1, Formula e and Formula 2 cars be shipped to its contractor in England for testing prior to shipment to the teams. Each Halo supplied to F1 and Formula e teams had to be approved for use by FIA.

37. Mercedes, RBR and Ferrari imported the inventions and used them at the COTA Grand Prix in 2018 and 2019, and supplied or caused to be supplied components that made up the invention, including components with no substantial non infringing use, for export after those events. Mercedes also supplied or caused to be supplied the components that made up the invention, or supplied or caused to be supplied components, including components with no substantial non-infringing use, use other than in the inventions, from the U.S. to Great Britain after the 2019 U.S. ePrix.

[6] Haas Racing LLC is not joined as a party.

38. Mr. Nygaard again asked FIA in 2018 to compensate him for his patent rights, and again FIA flatly refused to do so. FIA did not even make an offer to license. Neither F1, Delta, Mercedes, Ferrari, RBT, RBR, Dallara nor others sought a license, even though they knew the Halo would be deployed as implemented in cars in the U.S. Grand Prix at COTA, other Formula races at COTA, the U.S. ePrix on New York City roads, by F1's U.S.-based F1 team (Haas Racing), by multiple Formula e teams based in the U.S., and Formula 3 and 4 teams in the U.S., among other times and places in this country. They also knew F1 cars and components, including components with no substantial non-infringing use, would be supplied from this county abroad, such that assembly would infringe the '178 patent.

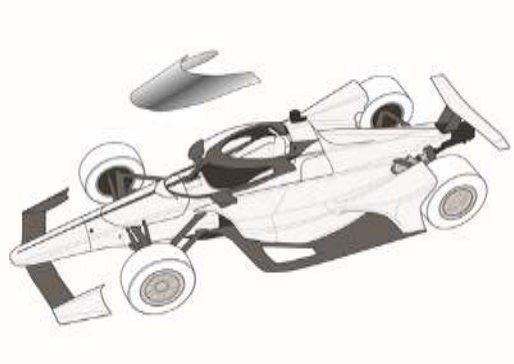
39. Since about 2011, RBT has worked with IndyCar and Dallara to develop a safety device for IndyCar Circuits, including IndyCar Circuit events at COTA and elsewhere in the U.S. The safety device is the Aeroscreen – a combined Halo and "jet windscreen" – but with a modification of the Halo developed during the Project. RBT's and RBR's Aeroscreen added a center pillar to create the Halo configuration adopted by the FIA. Testing of the Aeroscreen with the Halo in the configuration adopted by the FIA in 2017 was able to withstand the same stress as the FIA Halo.

40. It is significant that the original Aeroscreen design was not able to pass the FIA's 2017 strength tests. In May 2019, it was announced that IndyCar had adopted a redesigned Aeroscreen from a collaboration by RBT and Dallara, and that further testing would continue through 2019 to support its introduction in 2020. The design as adopted by IndyCar implemented the center pillar design as used in the FIA approved Halo. RBT and Dallara knew, intended and supplied Aeroscreen "kits" to all teams for IndyCar 500 and Indy Lights and other Indy circuits. Nearly all of these teams and races are in the U.S., and RBT and Dallara both acted intentionally

to induce infringement of the '178 patent or to contribute to its infringement by supplying parts with no substantial non-infringing use but for in the invention.

41. FIA's lengthy safety Project, IndyCar's monitoring of that Project, and IndyCar's own adoption of the Aeroscreen based on the Halo, show that only the Halo provided the necessary strength to protect race drivers that was acceptable to either FIA or IndyCar.

42. Below is a diagram of the Aeroscreen as completed for IndyCar circuits shown on a Dallara DW12 chassis.



43. In 2019, Dallara began assembling at its facilities in Italy and importing into the U.S., equipment for adaptation of the DW12 chassis to implement the Aeroscreen sold by RBT; and this activity continued into early 2020.

44. The first, and as of now, only public, ticketed IndyCar event where all teams participated with the Aeroscreen was the 2020 NTT IndyCar Series Official Practice on February 11, 2020 at COTA. The Aeroscreen was used at subsequent closed practices at COTA and Texas Motor Speedway. Dallara made these Aeroscreens and the chassis for each of these cars. Dallara and RBT made and imported the Aeroscreen in late 2019 and early 2020 into the U.S. for the 2020 NTT IndyCar Series, including implementation on cars for the events at COTA and Texas Motor Speedway in February 2020.

45. Mr. Nygaard is grateful that his patented inventions have saved drivers from death and serious injury since 2018. Mr. Nygaard wants his inventions to continue to protect people. Mr. Nygaard, however, in all fairness and as a matter of law, is entitled to be compensated by those who have knowingly exploited his patented inventions for their own gain.

III. PARTIES

46. Mr. Nygaard is a citizen of Norway and domiciled in Glomfjord, Norway.

47. Fédération Internationale de l'Automobile is a French non-profit association. It can be served under Fed. R. Civ. P. 4 through any one or more of the following:

a) by service on the Texas Secretary of State, P.O. Box 12079, Austin, Texas 78711-2079 FIA may be served through the Texas Secretary of State, i) under Texas Civil Practice and Remedies Code Section 17.044(b): 1) FIA is a non-resident who engages in business in this state; but 2) does not maintain a regular place of business in this state or a designated agent for service of process; and 3) the claims herein arise out of business it conducted and continues to conduct in Texas regarding at least the 2018 and 2019 U.S. Grand Prix at COTA and 2019 F4 United States Championship Races at COTA. ii) Further, or alternatively, FIA may also be served through the Texas Secretary of State under Texas Civil Practice & Remedies Code Section 17.044(a)(1) because it is a non-resident entity that is required by statute to designate or maintain a resident agent or engages in business in this state, but has not designated or maintained a resident agent for service of process here. In addition to the facts set forth in the preceding paragraphs, FIA also does business in Texas by its role in the FIA World Endurance Championship, including but not limited to the 2020 WEC Lone Star Le Mans World Championship at the COTA in February 2020.

b) alternatively by Hague Convention for Service of Process (the "Hague") on Mr. Jean-Baptiste Pinton, FIA's Chief Administrative Officer, at FIA GENÈVE, Chemin de

Blandonnet 2, 1214 Vernier/GE, Switzerland, Telephone: +41 22 544 44 00, Fax: +41 22 544 44 50; and/or alternatively,

c) FIA can also be served by mail under Fed. R. Civ. P. 4 on the President or Secretary of The Automobile Competition Committee for the United States, which is a member of FIA and the National Sporting Authority of the FIA for the United States, at 825 Ballough Rd, Suite 200-C, Daytona Beach, FL 32114.

48. Formula One Management Ltd. is a UK company located at No. 2 St. James's Market, London, United Kingdom, SW1Y 4AH, and can be served with process on its registered agent located at 206 E. 9th Street, Suite 1300, Austin, Texas 78701. It is an indirect subsidiary of Liberty Media.[7] Sacha Jane Woodward Hill is the Secretary of this entity and also a director of multiple Formula One and other Liberty entities, which share the same office in London. These entities are all ultimately owned directly or indirectly by Liberty Media.[8]

49. Delta Topco Ltd. is an Isle of Jersey company located at 1 Waverley Place Union Street St Helier Y9 JE1 1SG, and may be served with process on its registered agent located at 2711 Centerville Road, Suite 400, Wilmington, Delaware 19808. Upon information and belief, it

[7] LIBERTY MEDIA CORPORATION, UNITED STATES SECURITIES AND EXCHANGE COMMISSION FORM 10-K, FOR THE FISCAL YEAR ENDING DECEMBER 31, 2019, filed February 2020, at Part I, Item 1 "Business," Page I-1 ("Liberty Media Corporation ('Liberty', the 'Company', 'we', 'us' and 'our') owns interests in subsidiaries and other companies which are engaged in the global media and entertainment industries. Our principal businesses and assets include our consolidated subsidiaries Sirius XM Holdings (defined below), Formula 1, Braves Holdings, LLC ('Braves Holdings') and our equity affiliate Live Nation Entertainment, Inc. ('Live Nation')."). This report's discussion of Liberty Media's Formula 1 business illustrates the organizational complexity of Formula One Racing, especially when viewed in light of the chain of parent and subsidiary relationships from Formula One Management to Liberty Media Corporation as shown by public records from U.K. Company House. Mr. Nygaard believes by joining as Defendants Formula One Management Ltd., and Delta Topco Ltd., he has joined the correct entities, but reserves the right to join any other entity directly or indirectly controlled by Liberty Media Corporation as needed to ensure the correct Defendants are joined in this case. Courtesy copies of this complaint are being sent to Ms. Woodward Hall and Ms. Wilm to inform them and the Liberty GR, Liberty, Alpha and other Liberty Media Corporation entities about the lawsuit.

[8] Liberty Media Corporation is not joined as a party, but it and its subsidiaries and affiliates are now on notice of this lawsuit so that if any other or different entities should be joined as parties other than F1 or Delta, they can be joined without delay of the case.

is a direct or indirect subsidiary of Liberty GR Acquisition Company Limited, No. 2, St. James's Market London, United Kingdom, SW1Y 4AH. (Rene Lynn Wilm, Chief Legal Counsel of Liberty Media Corporation, is an officer of this entity; neither Liberty GR nor Liberty Media Corporation are joined as Defendants in this Complaint, but have been sent notice. Likewise, the other entities for which Ms. Woodward Hill serves as Secretary and/or director have also been so informed by delivery of this Complaint to her.)

50. Mercedes-Benz Grand Prix Ltd. ("Mercedes") is a UK company. It is an indirect subsidiary of Daimler AG. Mercedes can be served:

a) by service on the Texas Secretary of State, P.O. Box 12079, Austin, Texas 78711-2079, i) under Texas Civil Practice and Remedies Code Section 17.044(b): 1) Mercedes is a non-resident who engages in business in this state; but 2) does not maintain a regular place of business in this state or a designated agent for service of process; and 3) the claims herein arise out of business it conducted and continues to conduct in Texas regarding at least the 2018 and 2019 U.S. Grand Prix at COTA and marketing and sales of the team's memorabilia, clothing, shoes and other licensed goods to Texas residents. Further, Mercedes has raised substantial sponsorship revenue due in part to the U.S. Grand Prix races. ii) Mercedes may also be served through the Texas Secretary of State under Texas Civil Practice & Remedies Code Section 17.044(a)(1) because it is a non-resident entity that is required by statute to designate or maintain a resident agent or engages in business in this state, but has not designated or maintained a resident agent for service of process here.

b) alternatively, by the Hague on its Secretary, Shaila Ann Rao-Saodun, at its headquarters located at Operations Centre, Brackley, Northamptonshire, NN13 7BD, United Kingdom, or alternatively on either of its Directors, Toto Wolff or Rene Berger, at that same location.

51. Ferrari S.p.A. and its subsidiary and/or division, Scuderia Ferrari S.p.A., are entities organized under the laws of Italy, with their headquarters in Maranello, Italy, and can be served,

a) by mailing the Complaint(s) under Fed. R. Civ. P. 4 to their Chief Executive Officer, Louis C. Camillari, at an office he maintains at 120 Park Avenue, New York, NY 10017.

b) alternatively, Ferrari S.p.A. and Scuderia Ferrari S.p.A. may be served through the Texas Secretary of State, P.O. Box 12079, Austin, Texas 78711-2079 under i) Texas Civil Practice and Remedies Code Section 17.044(b): 1) the Ferrari entities are non-residents who engage in business in this state; but 2) do not maintain a regular place of business in this state or a designated agent for service of process; and 3) the claims herein arise out of business they conducted and continue to conduct in Texas regarding at least the 2018 and 2019 U.S. Grand Prix at COTA and marketing and sales of the team's memorabilia, clothing, shoes and other licensed goods to Texas residents. The Ferrari entities have raised substantial sponsorship revenue due in part to the U.S. Grand Prix races at COTA. ii) Further, or alternatively, they may also be served through the Texas Secretary of State under Texas Civil Practice & Remedies Code Section 17.044(a)(1) because they are non-resident entities required by statute to designate or maintain a resident agent or engages in business in this state, but have not designated or maintained a resident agent for service of process here.

c) alternatively, Ferrari can be served by the Hague Convention at its headquarters at Via Abetone Inferiore, 4, 41053 Maranello MO, Italy.

52. Red Bull Technology Ltd. ("RBT") and its subsidiary Red Bull Racing Ltd. ("RBR") are UK companies. They are indirect subsidiaries of Red Bull GmbH. RBT and RBR can be served,

a) by service on the Texas Secretary of State, P.O. Box 12079, Austin, Texas 78711-2079, i) under Texas Civil Practice and Remedies Code Section 17.044(b): 1) RBR and RBT are non-residents who engages in business in this state; but 2) do not maintain a regular place of business in this state or a designated agent for service of process; and 3) the claims herein arise out of business they conducted and continue to conduct in Texas regarding at least the 2018 and 2019 U.S. Grand Prix at COTA, RBT's supply and support of the Aeroscreen for the NTT IndyCar Series Circuit Official Practices in February 2020 at COTA and Texas Motor Speedway, as well as their support of their product at these events, and RBR's marketing and sales of the team's memorabilia, clothing, shoes and other licensed goods to Texas residents. Further, RBR raised substantial sponsorship revenue due in part to the U.S. Grand Prix races at COTA. ii) or alternatively, they may also be served through the Texas Secretary of State under Texas Civil Practice & Remedies Code Section 17.044(a)(1) because they are non-resident entities required by statute to designate or maintain a resident agent or engage in business in this state, but has not designated or maintained a resident agent for service of process here.

b) they can also be served by the Hague Convention through its Secretary, Laytons Secretaries Ltd., Level 5, 2 More London Riverside, London, United Kingdom, SE1

53. Dallara Automobili S.p.A. is an entity organized under the laws of Italy, with its headquarters at Via Provinciale 33 Varano de' Melegari, 43040 Italy. Dallara can be served

through its registered agent for service of process in Indiana, Mr. Stephano Deponti, 1201 Main Street, Indianapolis, IN, 46224, USA.

IV. NATURE OF THE ACTION

54. This is a case for direct and indirect patent infringement, literally or under the doctrine of equivalents, against each of the Defendants of U.S. Patent No. 7,494,178, titled "Vehicle And a Strengthening Member For a Vehicle." The patent was issued on February 24, 2009. Mr. Nygaard has always been the owner of all right, title, and interest in and to the '178 patent.

V. JURISDICTION AND VENUE

55. This action arises under the patent laws of the United States, Title 35 of the United States Code ("U.S.C.") § 101 *et seq.*

56. This Court has subject matter jurisdiction over this action under 28 U.S.C. §§ 1331 and 1338(a).

57. This Court has personal jurisdiction over each Defendant under the Texas Long-Arm Statute, Tex. Civ. Prac. & Rem. Code §§ 17.041 *et seq*. because each of them has infringed the patent directly and/or indirectly in the State of Texas. Each Defendant had notice of and can fairly be sued here because:

a) FIA, F1, Delta, Mercedes, Ferrari, RBT and RBR induced each F1 team to infringe in connection with one or more of the 2018 and 2019 U.S. Grand Prix races, qualifying rounds, and practices at COTA, by making and using the inventions there, and by F1 teams' drivers using the inventions there.

b) Upon information and belief, F1, Delta and FIA induced all F1 teams to import their vehicles and parts following the 2019 Mexico Grand Prix to ports of entry to this country located in Texas.

c) Following the 2018 U.S. Grand Prix at COTA, FIA, F1 and Delta caused each F1 team to supply from Texas their vehicles and parts, including components with no substantial non-infringing use, that if assembled in the U.S. would infringe the patent, to Mexico for the Mexican Grand Prix.

d) Following the 2019 U.S. Grand Prix at COTA, FIA, F1 and Delta caused each F1 team to supply from Texas their vehicles and parts, including components with no substantial non-infringing use, that if assembled in the U.S. would infringe the patent, to the Brazilian Grand Prix in Brazil, and induced others to also do so.

e) Mercedes won the 2019 U.S. Grand Prix at COTA using a car that infringed the '178 patent. Mercedes gained substantial benefit from this victory. In 2018 and 2019, Mercedes directly infringed the patent at the U.S. Grand Prix and related events at COTA by making and using the invention, and inducing its drivers, to use the invention in those races. In 2018 and 2019, Mercedes imported the invention into Texas for U.S. Grand Prix events at COTA. In 2018, Mercedes supplied or caused to be supplied to itself its cars and components, including components with no substantial non-infringing use, from Texas to Mexico for the Mexican Grand Prix and related events where such would infringe the patent if assembled for use in the U.S. In 2019, Mercedes supplied or caused to be supplied to itself its cars and components, including components with no substantial non-infringing use, from Texas to Brazil for the Brazilian Grand Prix and related events.

f) FIA induced F4 teams and their drivers that participated in the 2019 F4 U.S. Championship and related events at COTA to infringe by using cars implementing the Halo. Dallara induced infringement by designing and promoting its chassis for Formula 4 cars for use at COTA and other places in Texas.

g) F1 has a registered agent for service of process in the State of Texas because it does business in Texas at least in regard to the U.S. Grand Prix events and media and other commercial exploitation, which has been held annually at COTA since 2012, and is next scheduled for COTA in October 2020, as well as sale of merchandise in connection with, and media rights for, its U.S. Grand Prix events at COTA.

h) RBT and Dallara induced all teams and their drivers participating in the 2020 IndyCar Series Official Practices at COTA and Texas Motor Speedway to use the Aeroscreen by importing them, knowing the Aeroscreen would be deployed there, and by providing support for them at those events. RBT also participated in a press conference in Austin, Texas on February 10, 2020 regarding the implementation of the Aeroscreen. Upon information and belief, RBT and Dallara also provided support for the cars deploying Aeroscreen at these events, to among, other things, deal with any faults in construction or design.

58. Venue is proper in this judicial district under 28 U.S.C. §§ 1391(c), 1400(b), because Defendants are not citizens of the United States and may be sued in any judicial district or any judicial district where they are subject to personal jurisdiction. As shown above, specific personal jurisdiction can be exercised over each Defendant based on the claims and acts in the complaint, including the fact that each of the Defendants has committed infringing acts in this District or induced direct infringement by others in this District in at least 2018, 2019 and/or 2020.

VI. JOINDER

59. Defendants may be joined in this action under Section 299 of Title 35, because Mr. Nygaard's claims result from their overlapping development of products that make-up or include the Halo. Mr. Nygaard's claims are based on common and/or overlapping facts showing Defendants directly or indirectly infringed in regard to preparations for, events at, and acts following, the 2018 and 2019, U.S. Grand Prix; the 2018 and 2019 U.S. ePrix; the 2020 NTT IndyCar Practice at COTA, and Texas Motor Speedway; and other times and places in this Country as alleged herein:

a) Mr. Nygaard's right to relief is asserted against each Defendant acting together with multiple other Defendants, who infringed or induced infringement or in the alternative with respect to or arising out of the same transaction, occurrence, or series of transactions or occurrences relating to the making, using, selling, offering for sale, or importing into the U.S. the patented invention, as well as causing to be supplied from the U.S. components, including those that have no substantial non-infringing use, and would infringe if assembled in the U.S., and inducing others to do so.

b) There are questions of fact common to all Defendants including at least:

i. Whether an automobile that implements the Halo or the 2019 Aeroscreen based on the Halo infringes the '178 patent, literally or under doctrine of equivalents?

ii. Whether protecting the heads and necks of drivers in Formula and IndyCar races is important, especially in light of the deaths or injuries of drivers Surtees, Massa, Wheldon, Bianchi, Wilson and Wickens?

iii. Whether the Halo or Aeroscreen could have prevented Alonso Massa's or Richard Wickens' injuries, or any of the deaths of Surtees, Wheldon, Bianchi and Wilson?

iv. Whether the Halo prevented substantial injuries to, or death of, Charles LeClerc at the 2018 Belgian Grand Prix, and other drivers in Formula racing in 2018 and 2019?

v. Whether and to what extent RBT, Dallara, IndyCar, F1, FIA, Ferrari, Delta, Mercedes and others shared information regarding the Halo, including but not limited to information about Mr. Nygaard and/or his patent?

vi. Whether Dallara's role in 2013 in developing the original Halo prototype, other work on the Halo and Aeroscreen, as well as the 2019-2020 RBT Aeroscreen kits for IndyCar, and other work on parts and equipment to adapt the DW12 chassis for IndyCar and Formula chassis for Formula e, Formula 2, 3 and 4 to meet the strength requirements for both IndyCar and FIA?

vii. Whether Mr. Nygaard's prior 2013 and 2018 offers to license, which FIA rejected, are probative of damages for infringement of the '178 patent?

viii. Whether Defendants willfully infringed Mr. Nygaard's patent rights at Formula Grand Prix events, Formula 4 events, and the NTT IndyCar Series Official Practice at COTA, and other places in the United States knowing before those events about the '178 patent, their direct or indirect infringement, literally or by doctrine of equivalents, and that they were not licensed?

ix. Whether, and if so how, the revenues and other financial terms of the contracts among Delta, FIA, F1, Mercedes, Ferrari, RBR and others, evidence Defendants' actions, intent, motivations, willfulness, and damages owed to Mr. Nygaard?

x. Whether, and if so how, the revenues and other financial terms of the contracts among RBT, Dallara, and also their IndyCar customers and others, evidence Defendants' actions, intent, motivations, willfulness and damages owed to Mr. Nygaard?

xi. Whether Defendants' participation in, and/or monitoring of, the Project put them on notice of the '178 patent?

xii. Whether Defendants' participation in the Project and also participation in or role in one or more of 2018 and 2019 U.S. Grand Prix at COTA, or 2019 Formula e ePrix on New York roads, or making or using the invention by Haas Racing in the U.S., or Formula e teams in the U.S. (including Mercedes Formula e team), directly or indirectly infringe the '178 patent, literally or by doctrine of equivalents?

xiii. Whether the extent of any revenues resulting from making, using, selling, offering for sale in the U.S. or importing into the U.S. the infringing vehicles and components and/or components, including components with no substantial non-infringing use?

xiv. Whether the extent of any revenues resulting from supplying or causing to be supplied from the U.S., cars and/or components, including components with no non-infringing use, which would infringe the patent, literally or by doctrine of equivalents, if assembled in the U.S., or components with no non-substantial non-infringing use other than use in the invention?

xv. Whether and how facts about the design, modification and costs of infringing open cockpit vehicles built for use in Formula 1, Formula e, and other Formula

racing activities in the U.S. by car owners and by drivers during races and related events evidence infringement, willfulness and damages in this case?

xvi. Whether Defendants' contacts with Dallara for designing and making components to install and upgrade the DW12 chassis for the Halo for Formula Events or Aeroscreen in IndyCar events, and afterward in one or more of the 2018 and 2019 U.S. Grand Prix at COTA, the 2020 NTT IndyCarSeries Official Practices at COTA and Texas Motor Speedway, or 2019 Formula e ePrix on New York roads, or making or using the invention by Haas Racing in the U.S., or Formula e teams in the U.S. (including Mercedes Formula e team) constitute direct or indirect infringement the '178 patent, literally or by doctrine of equivalents?

xvii. Whether Defendants' knowledge of the Ferrari patent applications regarding a design like the Halo deployed in a Ferrari sports car, which was published in 2019, put them on further notice of Mr. Nygaard's patent?

xviii. Whether facts about how F1 teams have a voice in media and other exploitation of Grand Prix racing by Delta, F1 and FIA, including Mercedes, Ferrari and RBR gave them notice of Mr. Nygaard's patent, and caused indirect infringement of the patent, literally or by doctrine of equivalents?

xix. Whether facts about Dallara's DW12 chassis manufactured and sold for use in Formula e, Formula 3, Formula 4 and IndyCar circuits in the U.S., "kits" for those products, the upcoming replacement chassis for the DW12, and work or contacts among the other Defendants regarding those designs and products?

VII. COUNT I

Infringement of the ’178 patent by FIA, F1 and Delta Topco

60. Mr. Nygaard incorporates by reference each and every allegation in the preceding paragraphs.

61. Defendants FIA, F1 and Delta each induced infringement (literally or by doctrine of equivalents) in violation of Section 271(b) by each requiring that each of the ten teams and twenty drivers participating in the U.S. Grand Prix events at COTA from October 19-21, 2018 and November 1-3, 2019, use the claimed inventions all races, practices and qualifying rounds each year, used cars configured with the Halo per FIA regulations. Defendants FIA, F1 and Delta each induced the importation of and combination of components with no substantial non-infringing use, in the United States:

a) Ten teams competed in each of the 2018 and 2019 U.S. Grand Prix races, qualifying rounds and practices at COTA, using cars configured with the Halo, each directly infringing the ’178 patent (including Mercedes, Ferrari and RBR).

b) Twenty drivers competed in each of the 2018 and 2019 U.S. Grand Prix races using cars configured with the Halo, each directly infringing the ’178 patent (including Mercedes, Ferrari and RBR).

c) Haas Racing made and used cars in the U.S. configured with the Halo, directly infringing the ’178 patent, as required by FIA regulations.

62. F1, FIA and Delta each induced infringement in violation of Section 271(b),(c), literally or by doctrine of equivalents, by requiring the ten teams participating in the U.S. Grand Prix events in 2018 and 2019 to directly infringe, literally or by doctrine of equivalents, the ’178 patent by importing their cars, components, and equipment into the U.S. each year from other countries:

a) All (or nearly all) cars that participated in the 2018 U.S. Grand Prix race, practices, and qualifying races, were imported into the U.S. from Japan for the events at COTA by each team, directly infringing the ’178 patent.

b) All (or nearly all) cars that participated in the 2019 U.S. Grand Prix race, practices, and qualifying races, were imported into the U.S. from Mexico for the events at COTA by each team, directly infringing the ’178 patent.

c) Alternatively, in the event all components were not assembled into an infringing configuration at the time of import, then FIA, F1 and Delta induced contributory infringement by importation of components without no substantial non-infringing use, for the F1 cars that were to compete in the U.S. Grand Prix events in 2018 and 2019, including but not limited to cars with Halo and windscreens, among other components.

63. In violation of Section 271(f)(1) and/or 271(f)(2), FIA and F1 knowingly directly or indirectly infringed the ’178 patent, literally or by doctrine of equivalents, by causing to be supplied from the United States all or a substantial portion of the components of F1 race cars, where such components are uncombined in whole or in part, including components with no substantial non-infringing use, in such manner as to actively induce the combination of such components outside of the United States in a manner that would infringe the patent if such combination occurred within the United States:

a) in October 2018 from the United States following the U.S. Grand Prix at COTA to Mexico;

b) in November 2019 from the United States following the U.S. Grand Prix at COTA to Brazil.

64. FIA, F1 and Delta each had prior knowledge of the ’178 patent at least by 2013, through direct dealings between FIA and others with Mr. Nygaard in developing the prototype Halo according to his inventions. FIA, Delta and F1 had knowledge of the ’178 patent application through correspondence at least from 2006 by Mr. Nygaard to FIA, F1’s predecessor company and Mr. Bernie Ecclestone (who managed Delta’s FIA license and ran media and other commercialization of Formula One racing at the time).

65. Defendants have actively, knowingly, and intentionally induced conduct that constitutes infringement, literally or by doctrine of equivalents, of the ’178 patent, and intended that infringement at the time of committing the aforementioned acts, such that the acts and conduct have been and continue to be committed with the specific intent to induce infringement (or deliberately avoiding learning of the infringing circumstances at the time of committing these acts so as to be willfully blind to the infringement that was induced).

66. By inducing F1, Formula e and Formula 3 and 4 cars that implement Halo safety devices, to meet all the limitations of at least claims 1 and 4 of the ’178 patent, either literally or under the doctrine of equivalents, at COTA and other places in Texas and in the U.S.

67. Specifically, claim 1 of the ’178 patent below, with limitations bold and underlined, are met literally or by doctrine of equivalents, *at least* by the matters described in the bracketed material:

> A **strengthening member** [the Halo] for use in a **road vehicle** [automobile], for **fixing to a structure of the vehicle, and for extending in front of the driver’s position** [the vertical member of the Halo is fixed to the automobile at a point in front of the cockpit],

the **strengthening member** being dimensioned so that, when in use, **the strengthening member will not prevent the driver from seeing an object which is at least 2 m from the front windscreen,** [the driver can see objects, e.g., other cars, at this distance when the Halo is implemented on the vehicle] **when the driver uses binocular vision** [the driver uses binocular vision, e.g., drivers report that the vertical member of the Halo that extends in the front of the cockpit does not interfere with their vision when driving], **and without requiring the driver to move the driver's head** [the driver does not need to move his or her head to see objects when driving, e.g., other cars in front while driving],

wherein the **strengthening member** has the form of a triangular prism which has been sheared in a vertical plane or **the form of a truncated sheared triangular pyramid.** [Halo has the form of a truncated sheared triangular pyramid as formed by its angled vertical member in conjunction with the other angled portion].

68. Claim 4 of the '178 patent is infringed literally or by doctrine of equivalents:

A **road vehicle** [automobile] comprising at least one **strengthening member** [the Halo] **fixed to a structure of the vehicle** [the vertical member of the Halo is fixed to the front of the automobile chassis] **and extending in front of the driver's position** [the vertical member of the Halo extends in front of the cockpit],

wherein the **strengthening member** is dimensioned so that the **strengthening member will not prevent the driver from seeing an object which is at least two meters from the front windscreen** [the driver can see objects, e.g., other cars, at this distance when the Halo is implemented on the vehicle], **when the**

driver uses binocular vision [the driver uses binocular vision, e.g., drivers report that the vertical member of the Halo that extends in the front of the cockpit does not interfere with their vision when driving] and **without requiring the driver to move the driver's head,** [the driver does not need to move his or her head to see objects when driving, e.g., other vehicles in front while driving]

wherein the **strengthening member has the form of** a triangular prism which has been sheared in a vertical plane or **a truncated sheared triangular pyramid**. [Halo has the form of a truncated sheared triangular pyramid as formed by its angled vertical member in conjunction with the other angled portion].

69. Defendants are liable for infringement of the '178 patent, literally or by doctrine of equivalents, and their infringement has been and continues to be willful in nature.

70. Mr. Nygaard is entitled to actual and enhanced damages for this willful infringement pursuant to § 284, and attorneys' fees and costs under 35 U.S.C. § 285 as a result of the infringement of the '178 patent by Defendants because this is an exceptional case.

71. Therefore, Mr. Nygaard is entitled to actual and/or compensatory damages, reasonable royalties, pre-judgment and post-judgment interest, enhanced damages, attorneys' fees, and costs and any other relief to which he is entitled to receive from Defendants.

VIII. COUNT TWO

Infringement of the '178 Patent by Mercedes, Ferrari, RBT, RBR, and Dallara

72. Mr. Nygaard incorporates by reference each and every allegation in the preceding paragraphs.

73. The infringing Halo as implemented in Formula racing was developed from the Project.

74. Dallara designs and makes the DW12 chassis for Formula racing (other than F1) and IndyCar. Dallara participated in the Project, meeting directly with Mr. Nygaard. The Aeroscreen incorporating the Halo or Halo-like device was developed from the Project and from testing to improve the original Aeroscreen after the original design's rejection by the FIA. Mercedes, Ferrari, RBT, RBR and Dallara each participated in and supported the Project. Each of them learned of the '178 patent during the course of their participation in the Project and/or other means, before, during or since that time.

75. Each of their activities were intended to, among other things, encourage, induce and contribute to direct infringement, literally or under the doctrine of equivalents, by others making, using, selling, offering for sale, importing in or to the U.S., the following instrumentalities by the following entities and people:

a) F1 cars as used in 2018 and 2019 for the U.S. Grand Prix at COTA and related events by all F1 teams that participated in each of those races and by all drivers in each race, qualifying round and practice. Mercedes, Ferrari and RBR and their drivers by also directly infringed, literally or by doctrine of equivalents, by making the invention, and driving their cars on public and private roads, in the U.S.

b) F1 cars and teams supplying or causing to be supplied from the U.S. cars implementing the Halo, and components for cars, including components with no substantial non-infringing use, for export to Grand Prix races outside of the United States, specifically, in 2018 from COTA to Mexico and in 2019 from COTA to

Brazil, and from the United States, by each of their own staff for each of their own use in those events (including Mercedes, Ferrari and RBR).

c) Formula e cars used in 2019 for the U.S. ePrix and related events by all Formula e teams and by all drivers in each race, qualifying round and practice, including Mercedes' Formula e cars and their use by Mercedes' drivers.

d) Dallara designs, makes, and sells the chassis as well as other parts for Formula e cars and dealt with issues regarding the Halo. Dallara has imported into the U.S. DW12 chassis and parts for modification of them for implementation of Halo and Aeroscreen.

e) Formula e teams supplying or causing to be supplied from the United States cars implementing the Halo, and components for cars, including components with no substantial non-infringing use, for export in 2019 to their countries.

f) Haas Racing LLC F1 Team in the U.S. making and using the invention in its cars for roads at or near its facilities, for the F1 Grand Prix 2018 and 2019 Circuits, and supplying from the U.S. components including unique components with no substantial non-infringing uses, and vehicles, implementing the Halo.

g) F3 and F4 teams and other Formula racing teams making and using the cars in the U.S. that implement the Halo.

h) U.S. based Formula e teams in the U.S. making and using the invention in their cars on roads, near their facilities, prior to or for the Formula e ePrix 2019 Circuit, and supplying from the U.S. components including components with no substantial non-infringing uses, and vehicles, implementing the Halo.

76. Mercedes, Ferrari, RBT, RBR and Dallara are liable for infringement of the ’178 patent, directly and/or indirectly, literally or by doctrine of equivalents, and infringement has been and continues to be willful in nature.

77. Mr. Nygaard is entitled to actual and enhanced damages under § 284, and attorneys’ fees and costs under 35 U.S.C. § 285 as a result of the willful infringement of the ’178 patent because this is an exceptional case.

78. Therefore, Mr. Nygaard is entitled to actual and/or compensatory damages, reasonable royalties, pre-judgment and post-judgment interest, enhanced damages, attorneys’ fees, and costs, and any other relief to which he may show himself entitled to from Mercedes, Ferrari, RBT, RBR and Dallara.

IX. COUNT THREE

Infringement by RBT and Dallara of the ’178 Patent

79. Mr. Nygaard incorporates by reference each and every allegation in the preceding paragraphs.

80. RBT and Dallara indirectly infringed the ’178 patent, literally or by doctrine of equivalents, by inducing others to make and use its claimed inventions by testing and importing into the U.S. since at least 2019, the Halo as part of the Aeroscreen:

a) for testing in October and November 2019 in the U.S.; and,

b) by all NTT IndyCar Series teams at the February 2020 NTT IndyCar Official Practices at COTA and Texas Motor Speedway. RBT further induced infringement at those events by participating at a press conference in Austin, Texas, and working with the teams at these events. Upon information and belief, RBT and Dallara supported their team customers at COTA in dealing with the Aeroscreen.

81. RBT and Dallara are liable for indirect infringement, literally or by equivalents, of the ’178 patent and their infringement has been and continues to be willful in nature.

82. Mr. Nygaard is entitled to actual and enhanced damages pursuant to § 284 and attorneys’ fees and costs under 35 U.S.C. § 285 as a result of the infringement of the ’178 patent by RBT and Dallara because this is an exceptional case.

83. Therefore, Mr. Nygaard is entitled to actual and/or compensatory damages, reasonable royalties, pre-judgment and post-judgment interest, enhanced damages, attorneys’ fees, and costs.

X. PRAYER FOR RELIEF

84. In consideration of the foregoing, Mr. Nygaard respectfully requests that this Court enter an Order granting the following relief:

a) Enter judgment in favor of Plaintiff Jens H. S. Nygaard, that Defendants Fédération Internationale de l’Automobile, Formula One Management Ltd., Delta Topco Limited, mercedes-Benz Grand Prix Ltd., Ferrari S.p.A., Scuderia Ferrari, Red Bull Technology Ltd., Red Bull Racing, Ltd. and Dallara Automobilli S.p.A. have each infringed and each continue to infringe U.S. Patent No. 7,494,178, and finding that such infringement is willful;

b) Award Plaintiff Jens H. S. Nygaard all monetary relief available under the patent laws of the United States, including but not limited to actual and/or compensatory damages, reasonable royalties, pre-judgment and post-judgment interest, enhanced damages, and costs pursuant to 35 U.S.C. § 284;

c) Order Defendants to pay ongoing royalties in an amount to be determined for any continued infringement after the date that judgment is entered and that no injunction

issue so long as the Defendants pay the royalties as ordered by this Court and in the manner ordered by this Court;

d) Declare this case exceptional and award Plaintiff Jens H. S. Nygaard his reasonable attorney fees pursuant to 35 U.S.C. § 285; and

e) Grant Plaintiff Jens H. S. Nygaard such additional, other, or further relief as the Court deems just and proper.

XI. DEMAND FOR JURY TRIAL

85. Mr. Nygaard demands trial by jury on all issues so triable.

Dated: March 26, 2020

Respectfully submitted,

By: */s/ Danielle J. Healey*

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US007494178B2

(12) United States Patent
Nygaard

(10) Patent No.: US 7,494,178 B2
(45) Date of Patent: Feb. 24, 2009

(54) **VEHICLE AND A STRENGTHENING MEMBER FOR A VEHICLE**

(76) Inventor: **Jens H. S. Nygaard**, Ed. Balcon de Europa, Pt.5 1E, ES-29780 Nerja-Malaga (ES)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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§ 371 (c)(1),
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B60R 21/08 (2006.01)
B60R 21/13 (2006.01)

(52) **U.S. Cl.** **296/187.01**; 180/274; 280/748; 296/95.1; 296/193.06

(58) **Field of Classification Search** 180/274; 280/748, 749, 751, 752, 753, 756; 293/15, 293/24, 38, 112; 296/84.1, 95.1, 187.01, 296/187.04, 187.05, 96.18, 193.06
See application file for complete search history.

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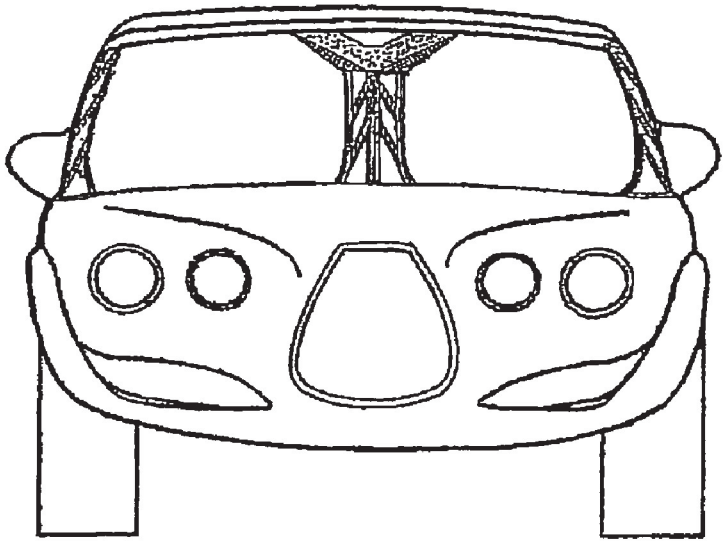
(57) **ABSTRACT**

The present invention provides a road vehicle having at least one strengthening member fixed to a structure of the vehicle, preferably extending adjacent to a front windscreen of the vehicle, between lateral edges of the front windscreen, wherein the strengthening member is dimensioned so that it will not prevent the driver from seeing an object which is at least two meters from the front windscreen. The present invention may further provide a road vehicle having at least one strengthening member which retracts to a first position and extends to a second position, and is movable from the first position to the second position. A particular type of strengthening member is formed of at least three first linearly extending structural units for extending from the front structure of the vehicle and second linearly extending structural unit joining the at least three first linearly extending units.

11 Claims, 23 Drawing Sheets



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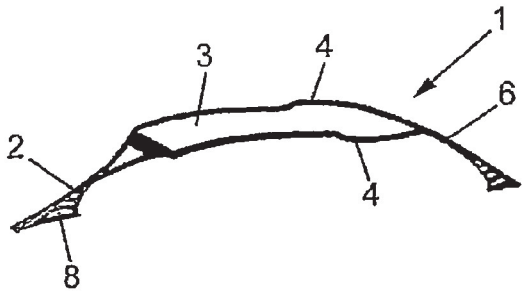
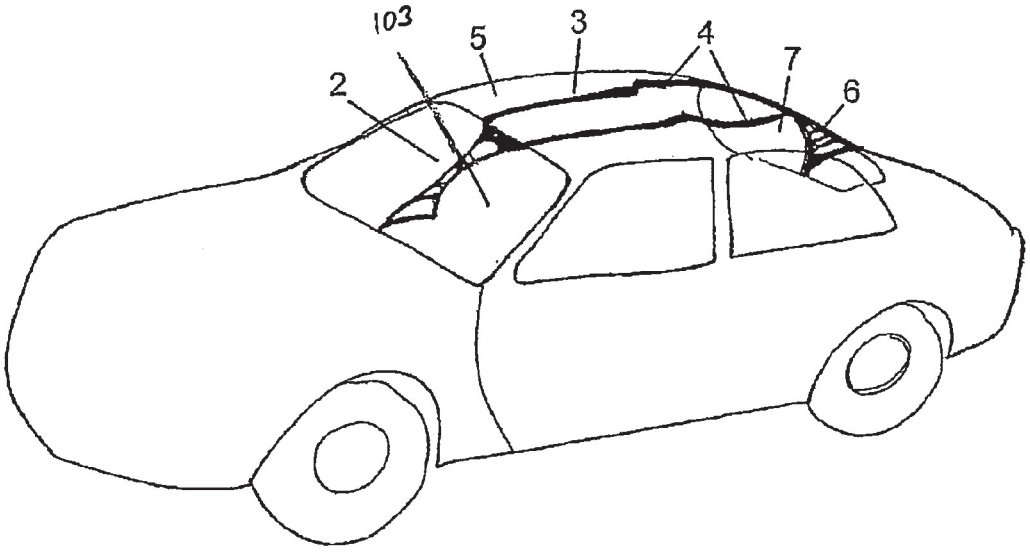


Fig. 1



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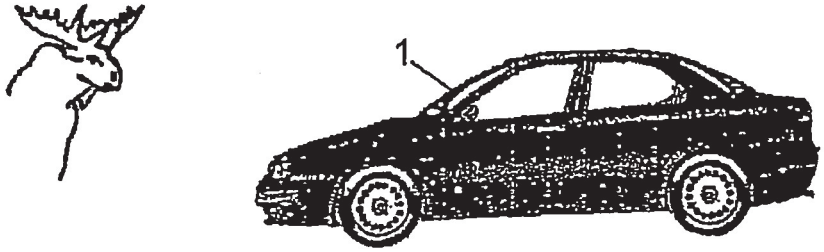
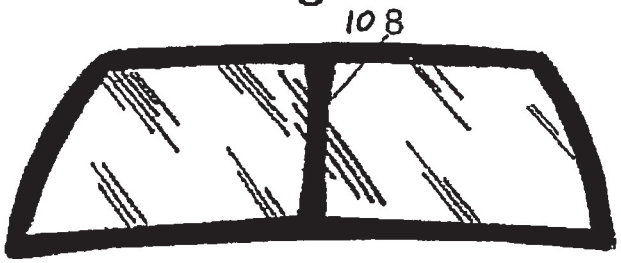


Fig. 3

Fig. 4

Fig. 5



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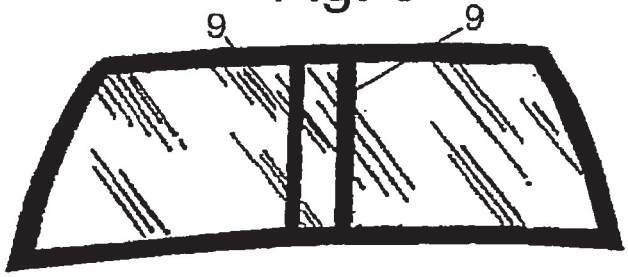

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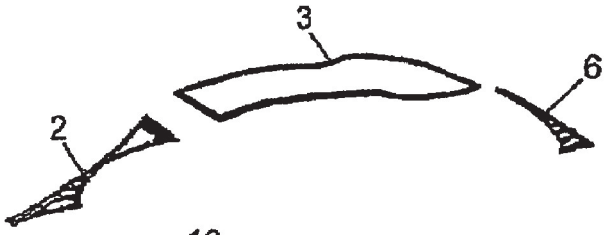

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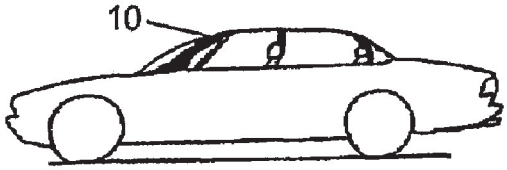

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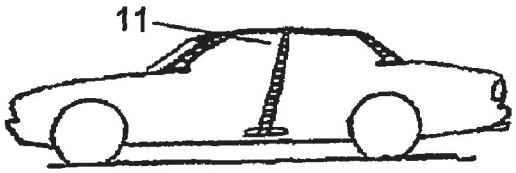

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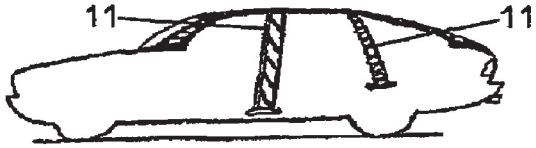

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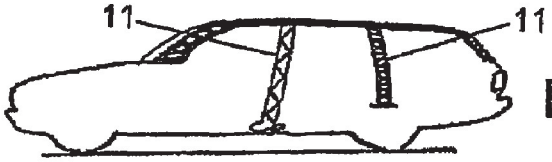

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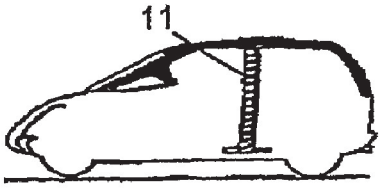

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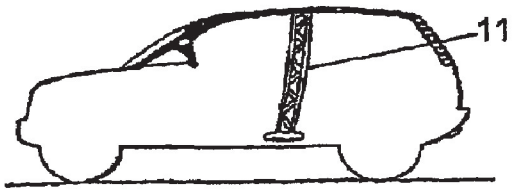

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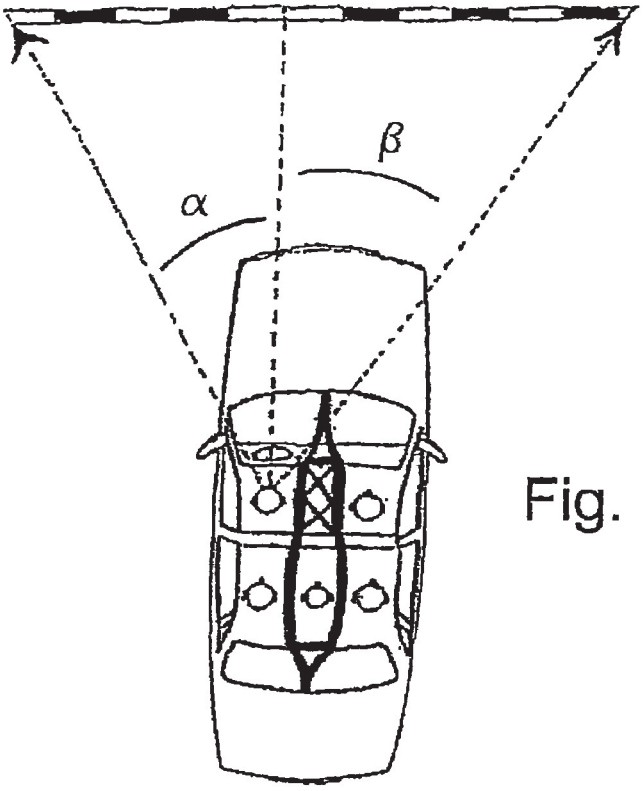

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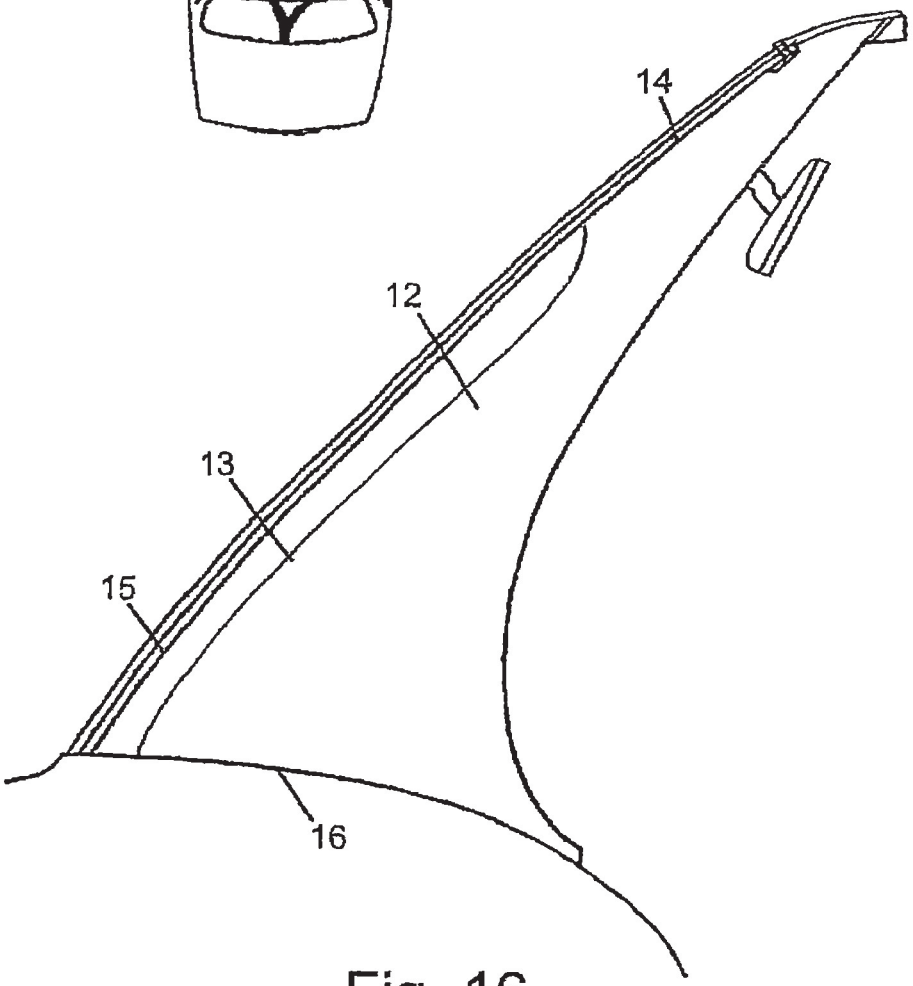

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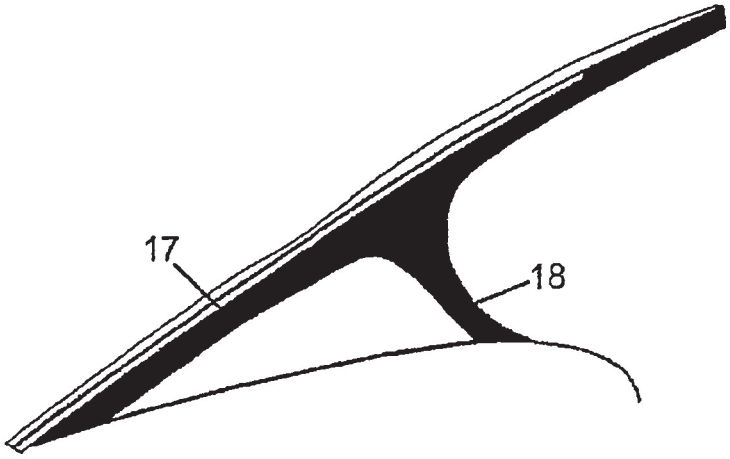

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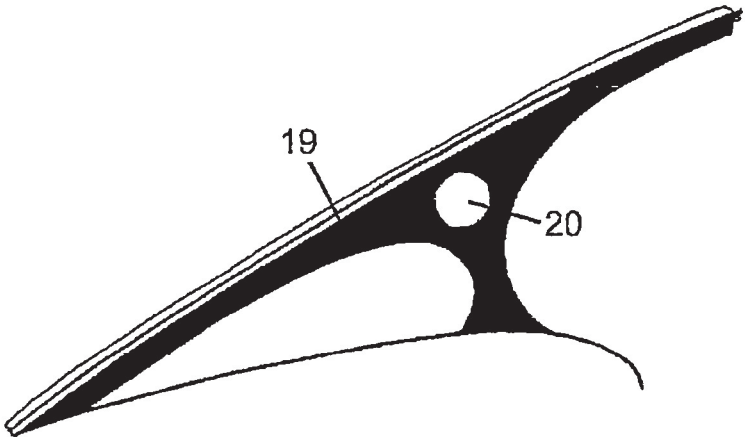

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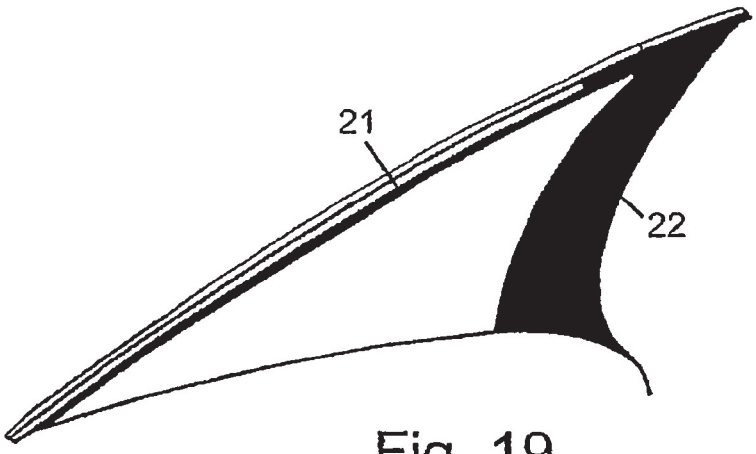

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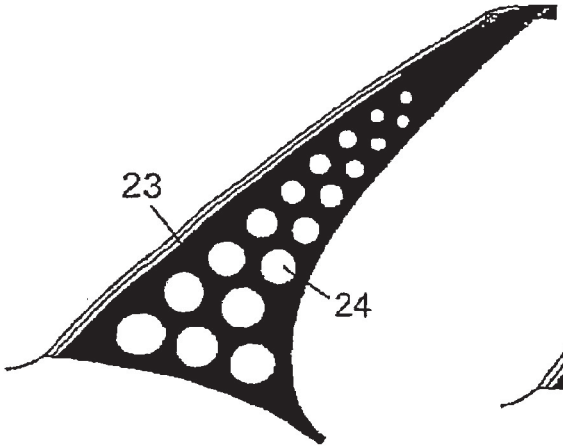

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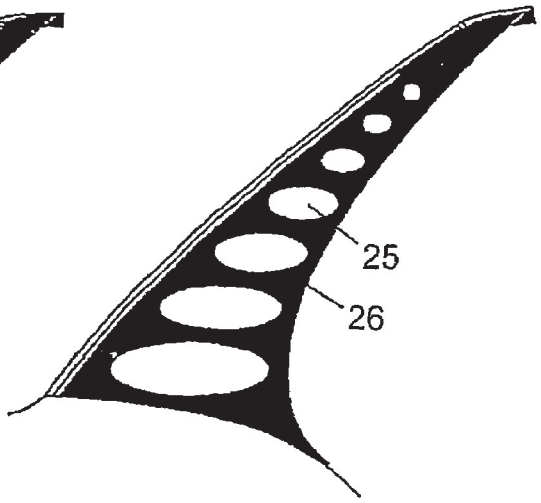

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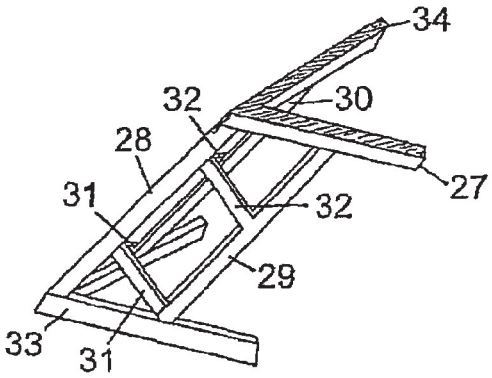

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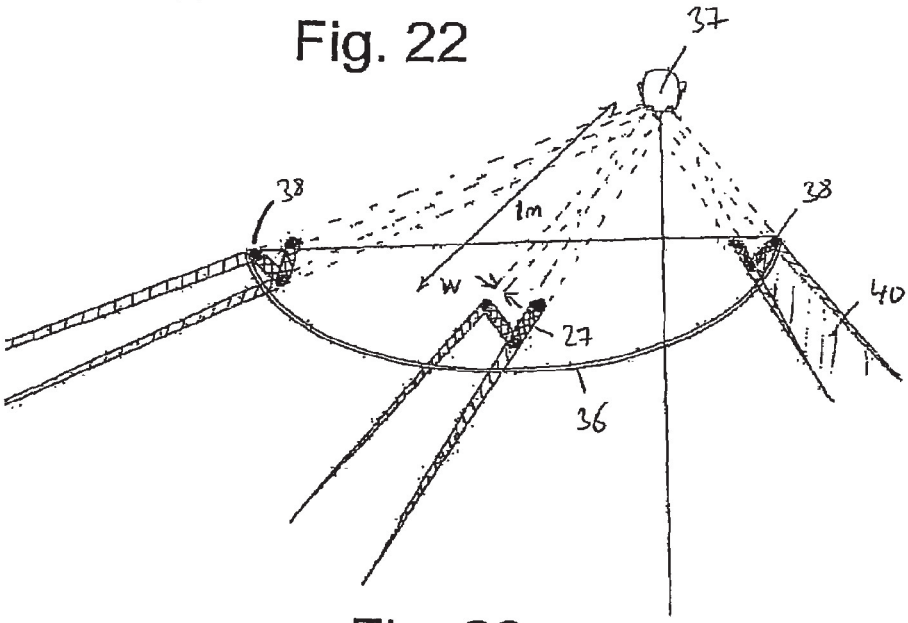

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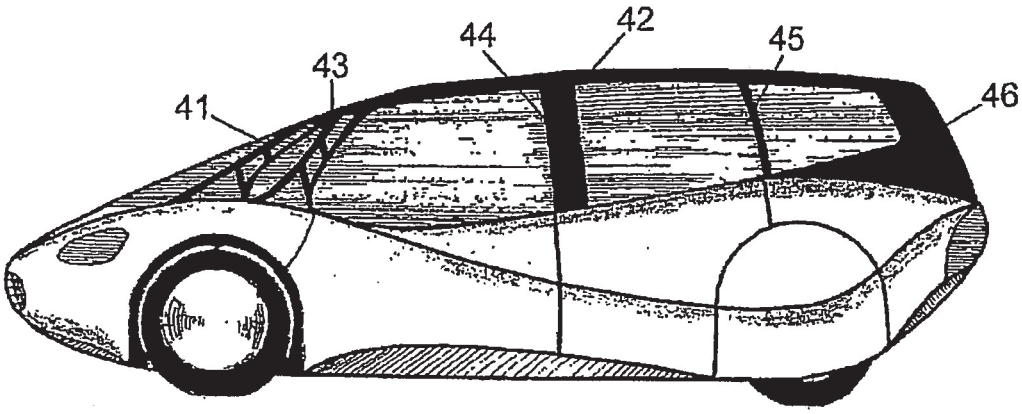

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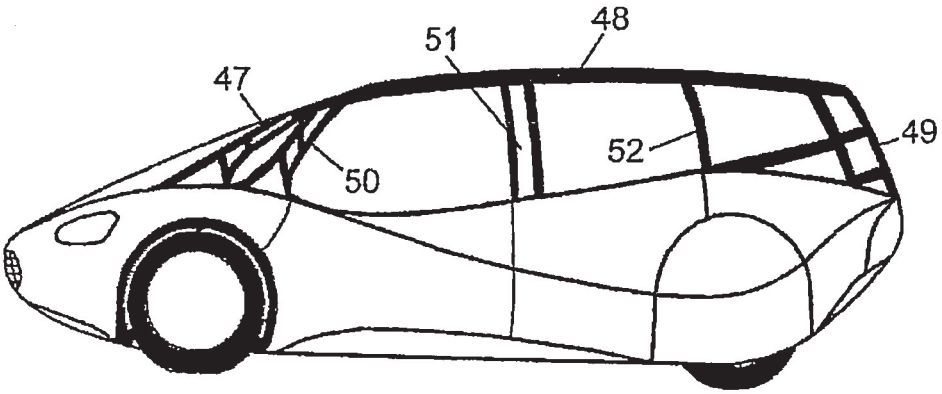

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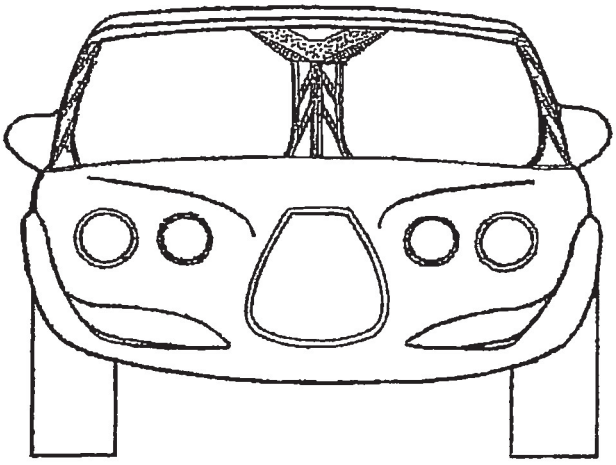

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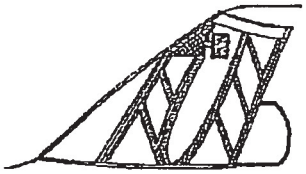

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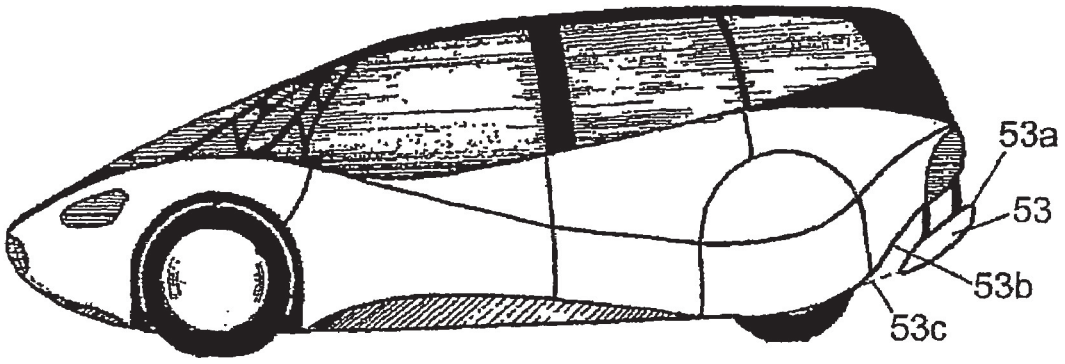

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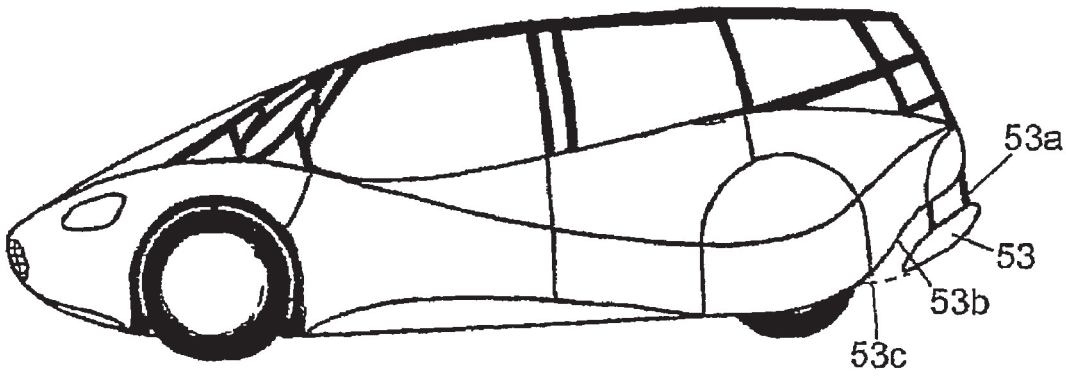

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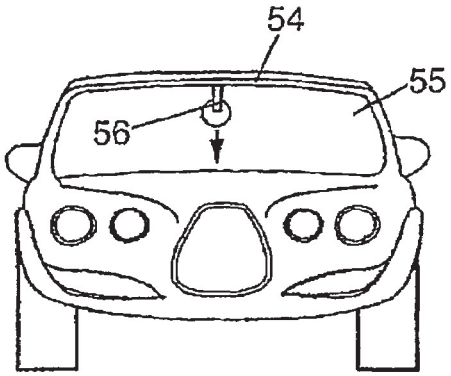

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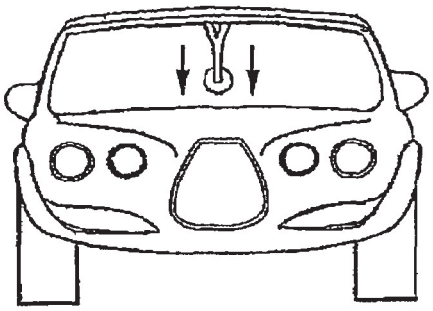

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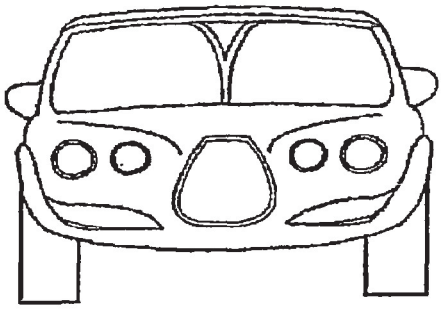

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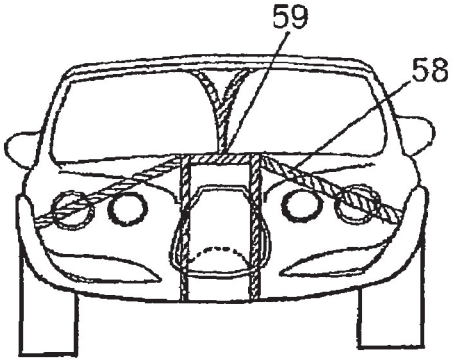

Fig. 30

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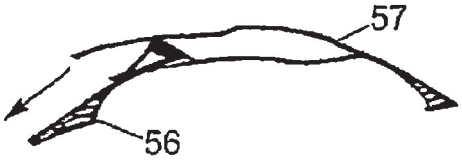
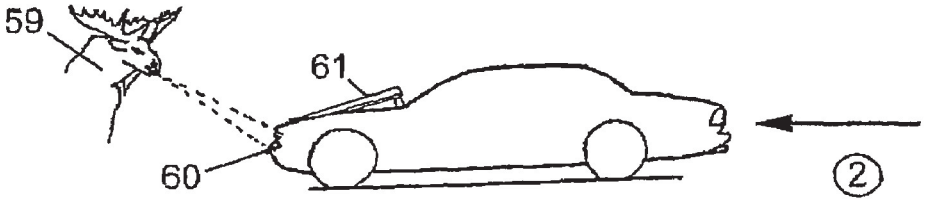


Fig. 32

Fig. 33

Fig. 34



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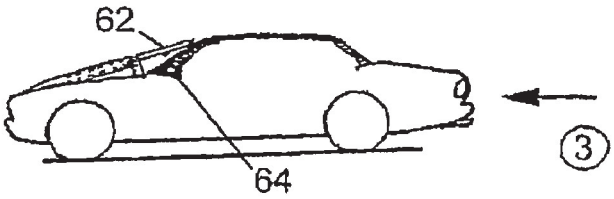

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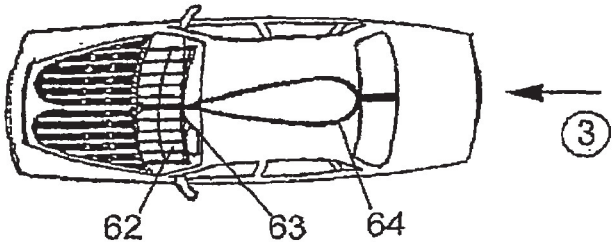

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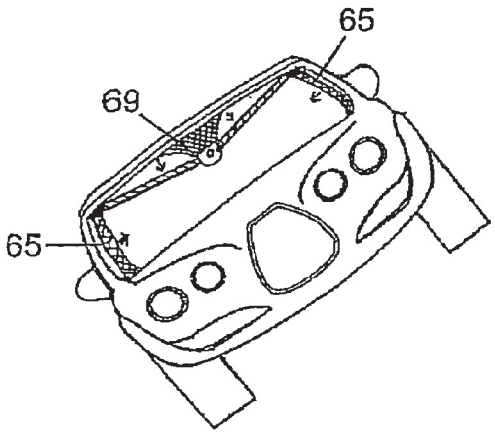

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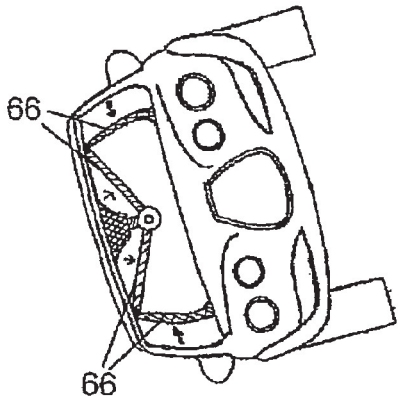

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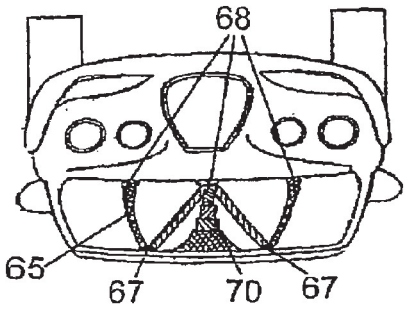

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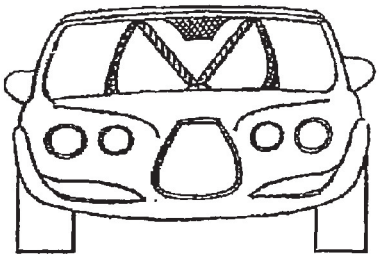

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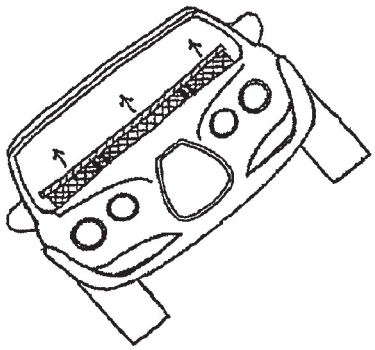

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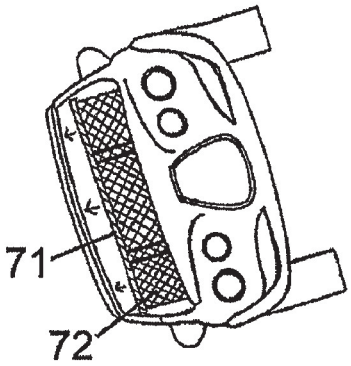

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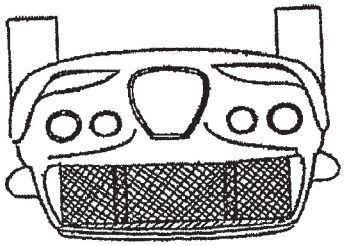

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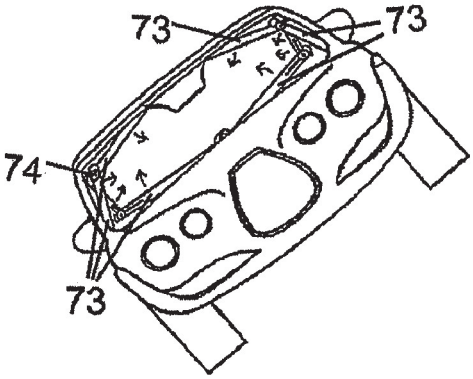

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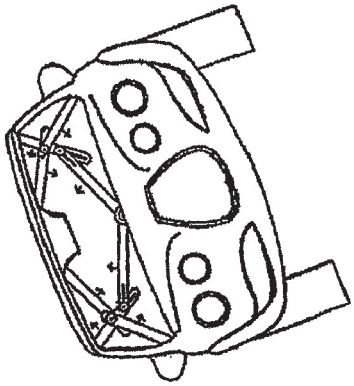

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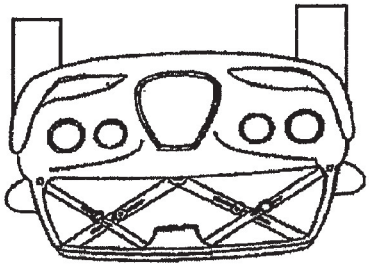

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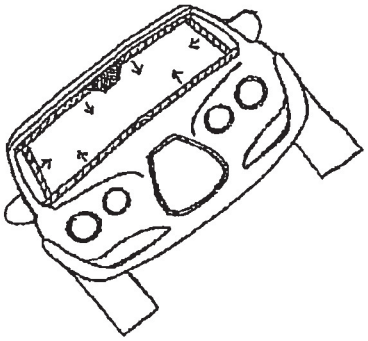

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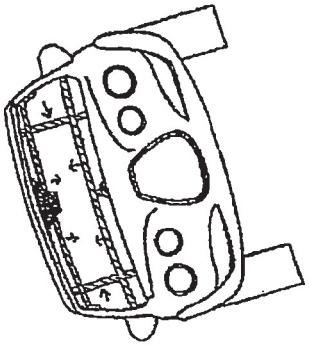

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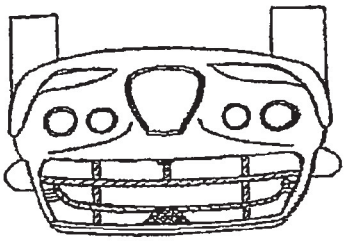

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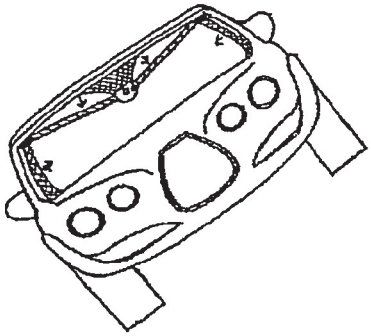

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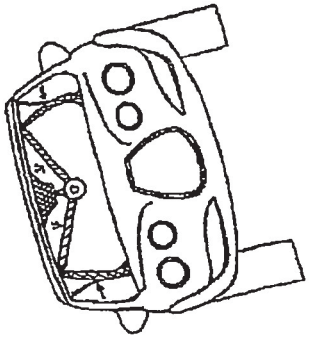

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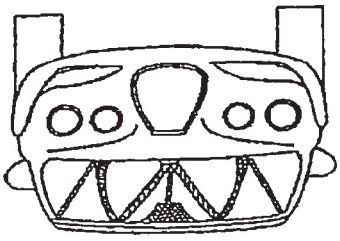

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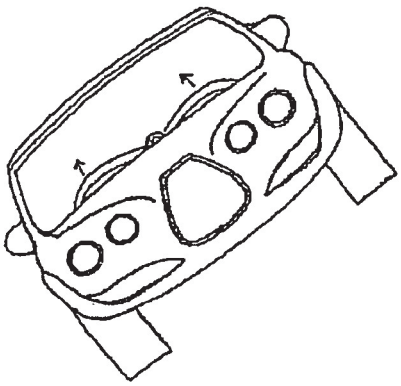

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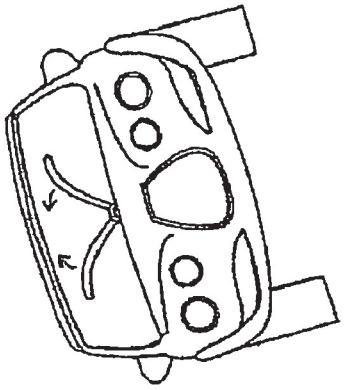

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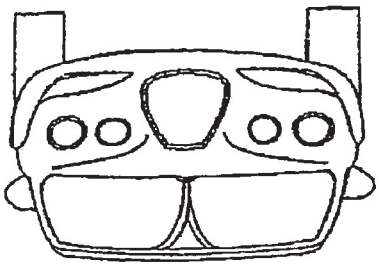

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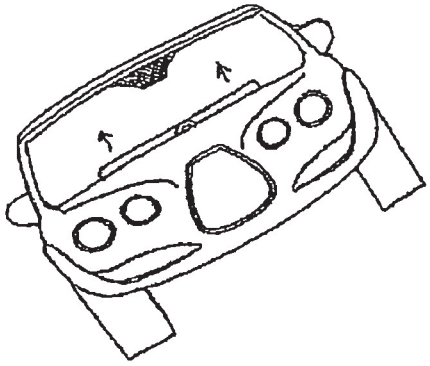

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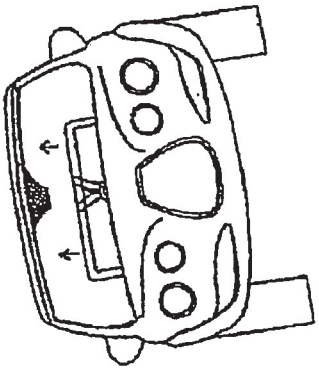

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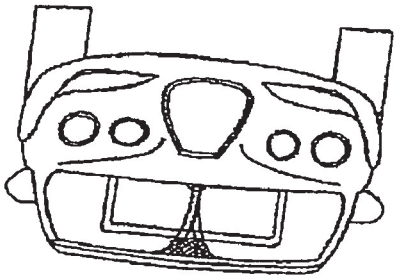

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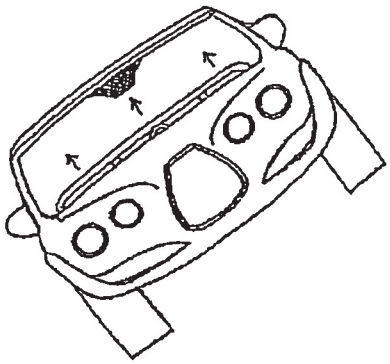

Fig. 46A

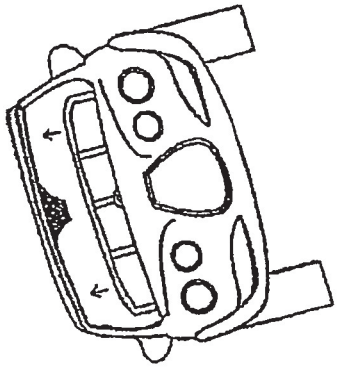

Fig. 46B

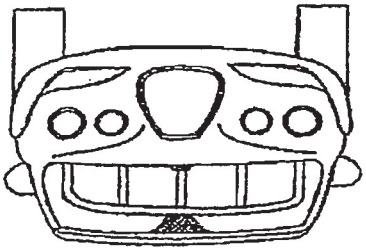

Fig. 46C

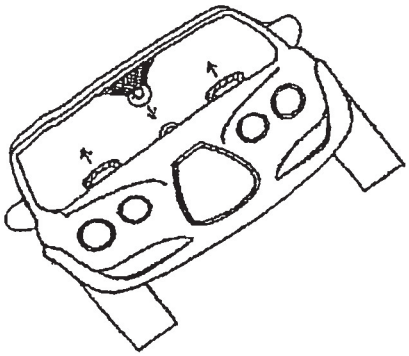

Fig. 47A

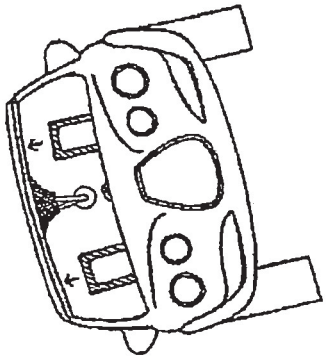

Fig. 47B

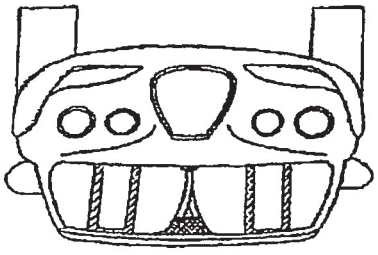

Fig. 47C

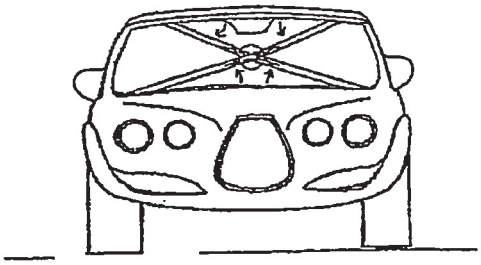

Fig. 48A

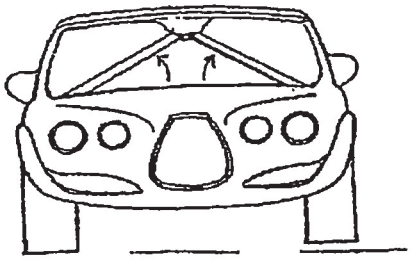

Fig. 48B

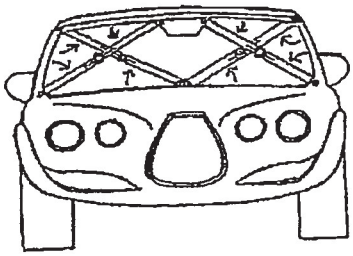

Fig. 48C

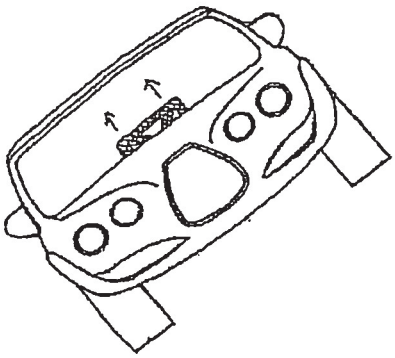

Fig. 49A

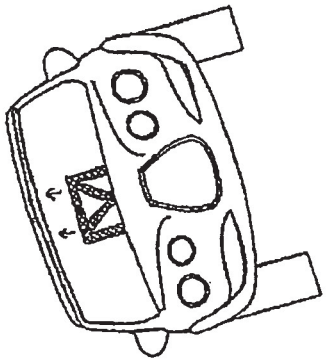

Fig. 49B

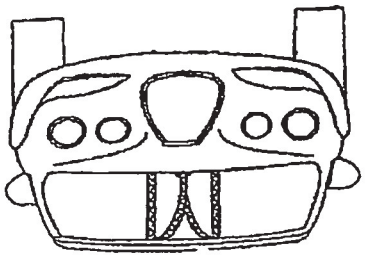

Fig. 49C

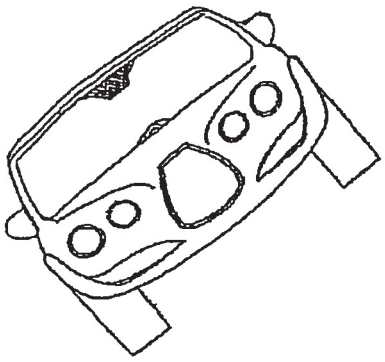

Fig. 50A

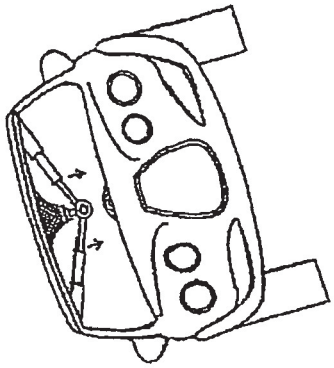

Fig. 50B

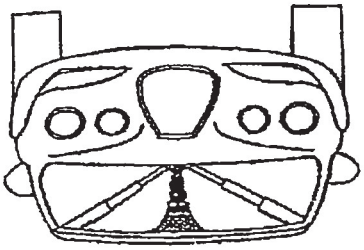

Fig. 50C

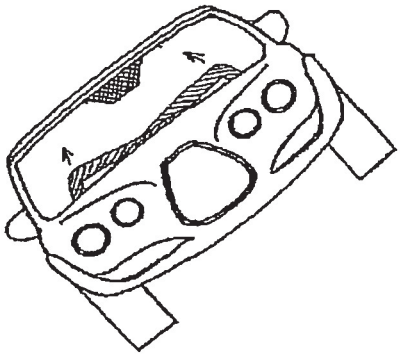

Fig. 51A

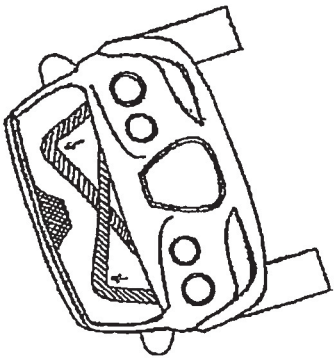

Fig. 51B

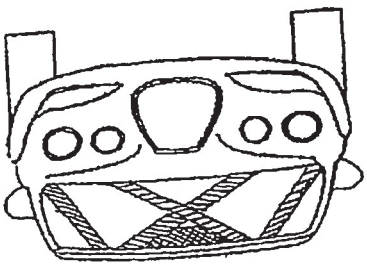

Fig. 51C

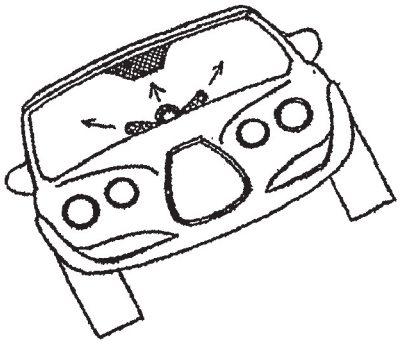

Fig. 52A

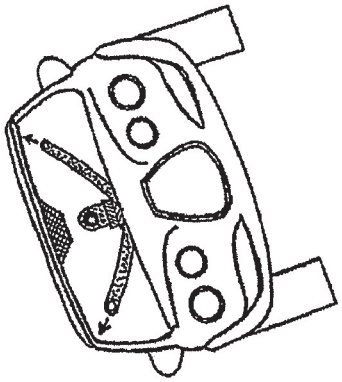

Fig. 52B

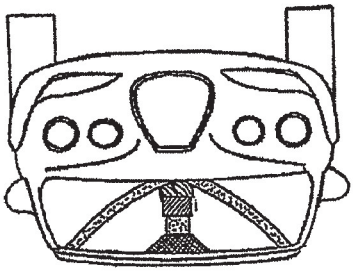

Fig. 52C

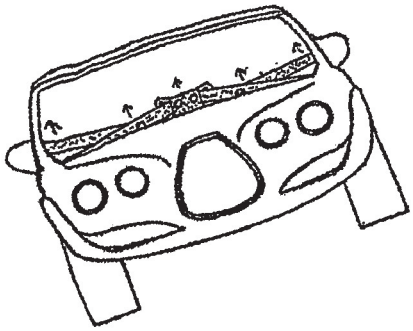

Fig. 53A

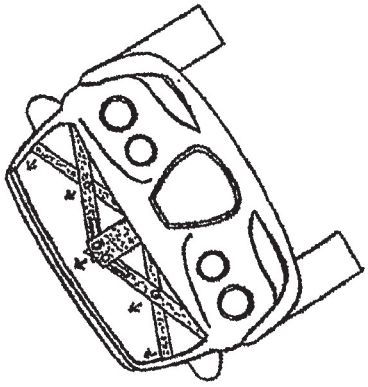

Fig. 53B

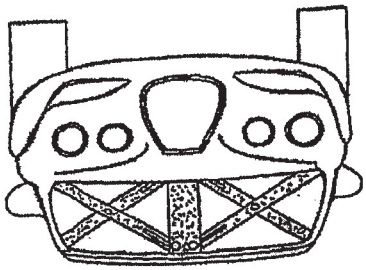

Fig. 53C

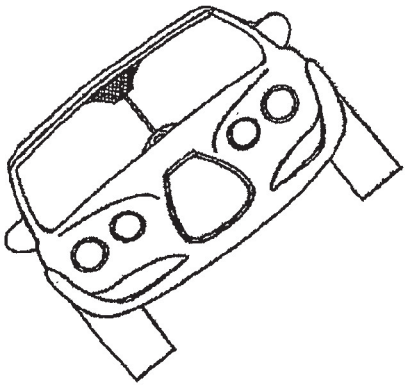

Fig. 54A

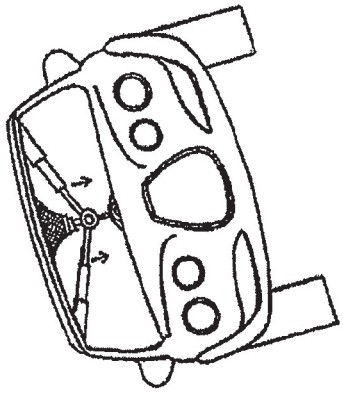

Fig. 54B

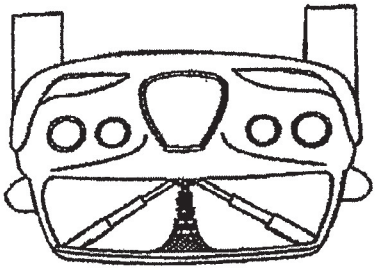

Fig. 54C

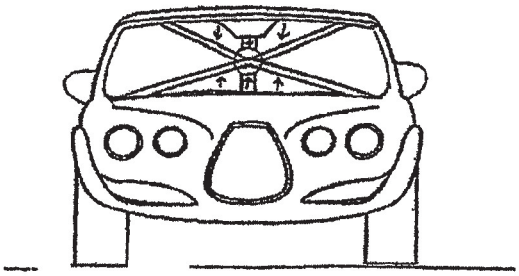

Fig. 55

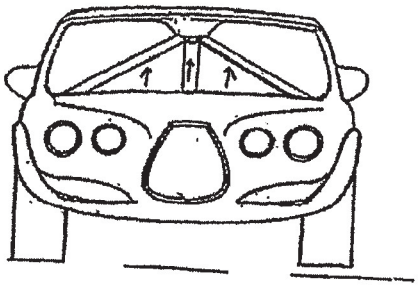

Fig. 56

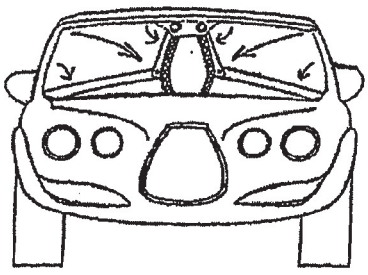

Fig. 57

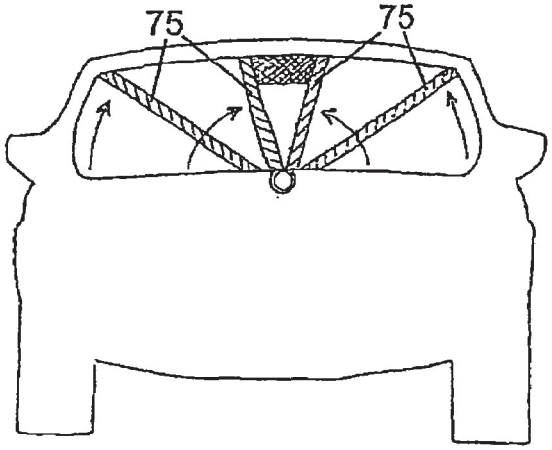

Fig. 58

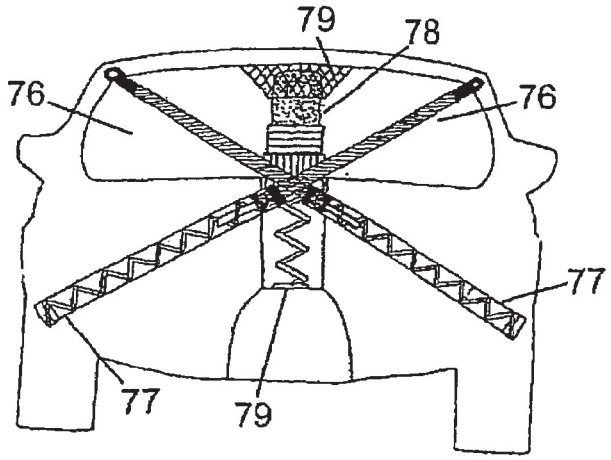

Fig. 59

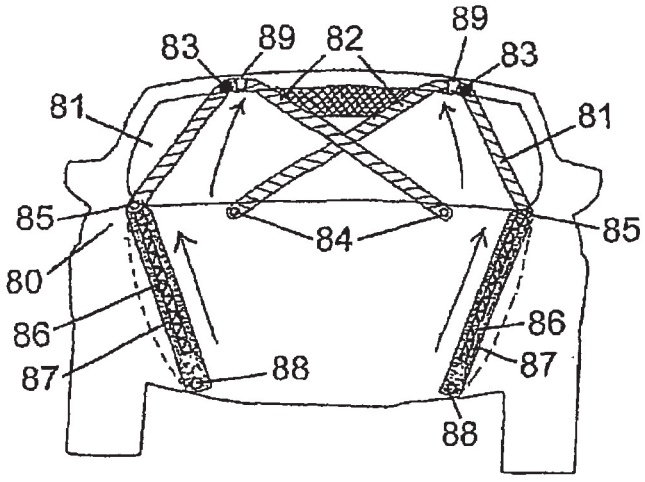

Fig. 60

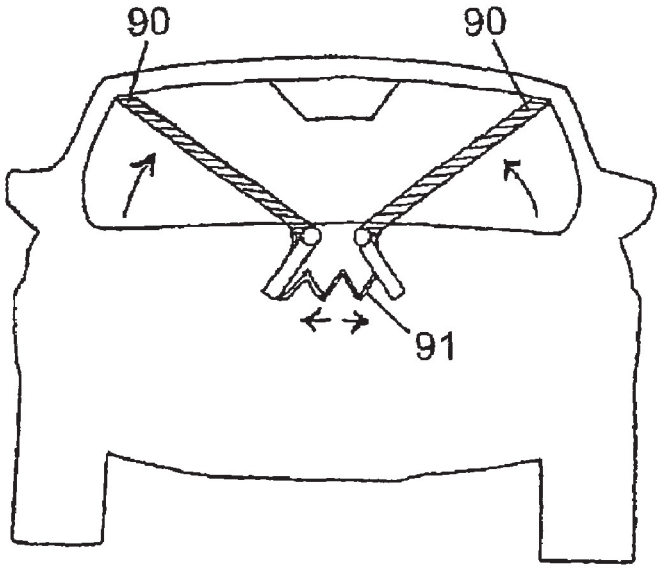

Fig. 61

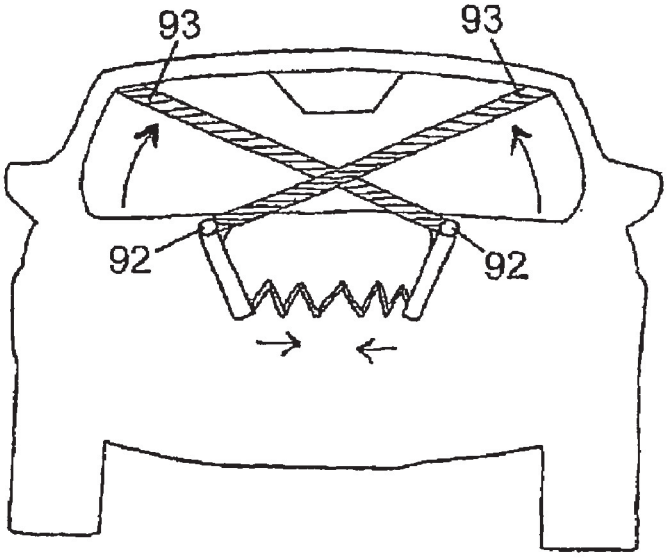

Fig. 62

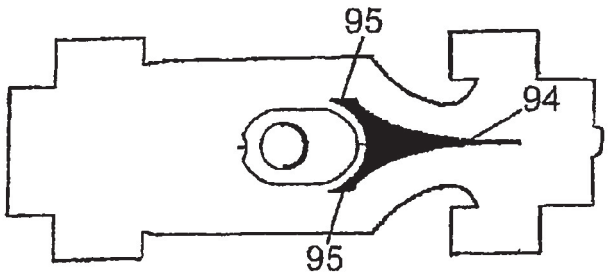

Fig. 63

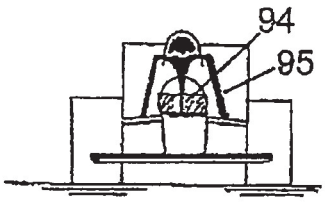

Fig. 64

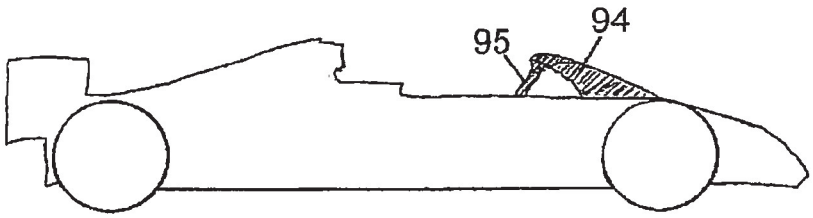

Fig. 65

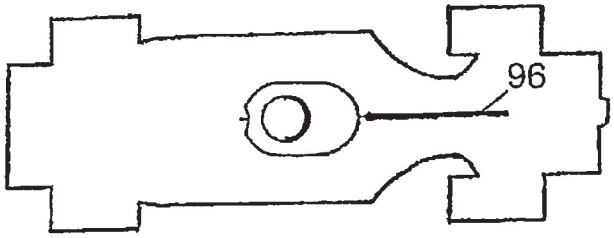

Fig. 66

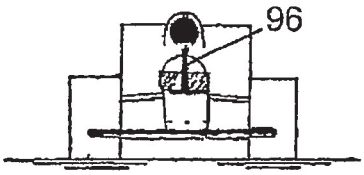

Fig. 67

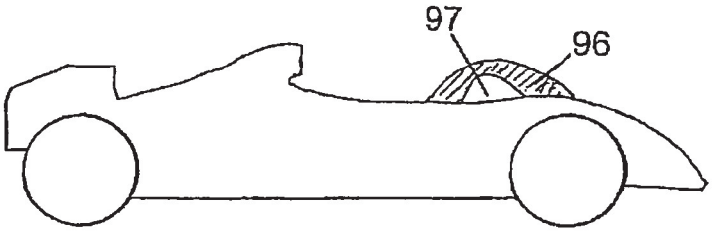

Fig. 68

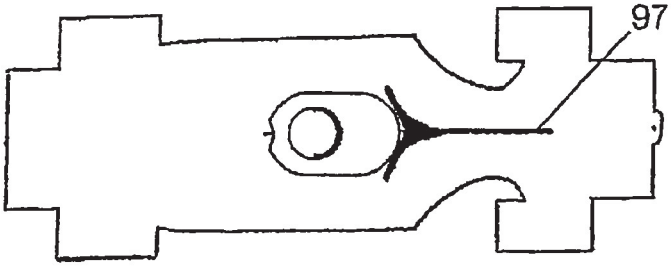

Fig. 69

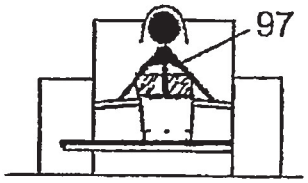

Fig. 70

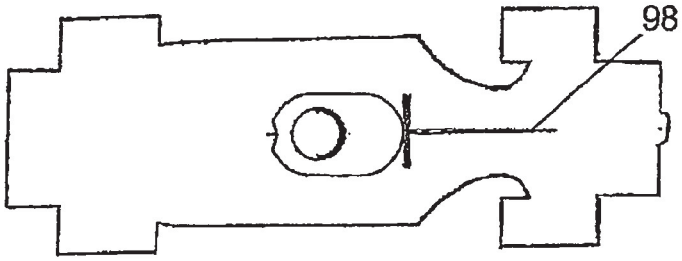

Fig. 71

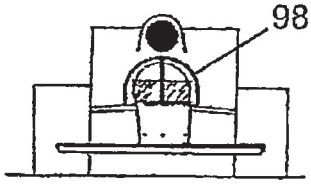

Fig. 72

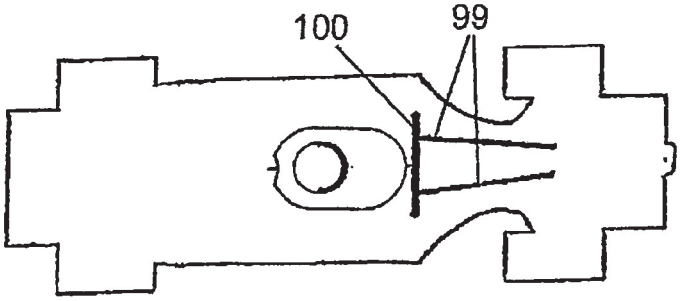

Fig. 73

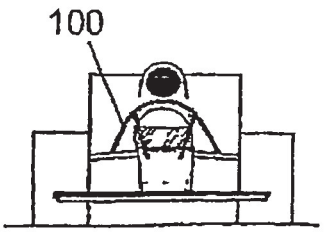

Fig. 74

VEHICLE AND A STRENGTHENING MEMBER FOR A VEHICLE

The present invention relates to structural reinforcements for the vulnerable areas of a vehicle, such as a road vehicle.

Many fatalities occur annually in road vehicle accidents. A proportion of these fatalities result from "looking but not seeing", caused by obstruction of field of vision by structures of the vehicle such as a-pillars, or from rollover roof crush or impact through the windscreen, which form the most dangerous forms of accident.

A number of systems have been employed in the past to reduce the effect of these accidents. For example, in U.S. Pat. No. 5,653,497 and U.S. Pat. No. 5,860,689 the windscreen is protected from roof crush by placing an impact resistant barrier around the periphery of the windscreen. The strengthening this provides only extends to the windscreen itself and there is some problem with an effect on peripheral vision through the windscreen.

It is also known in the field of motor racing to customize vehicles by welding in extra strengthening members. However, these strengthening members are not appropriate for normal vehicles, because they are very obstructive and potentially dangerous for persons traveling the vehicle. They can obstruct the space within the vehicle and obstruct vision.

Sports utility vehicles (SUV) are commonly provided with roll bars which are intended to provide vertical protection in a rollover accident, but are unable to protect against windscreen impacts. A number of systems have been provided in which the bonnet of a vehicle is raised upon impact, for example by the operation of impact sensors, but the protective effect is not found to be sufficient and the driver is not able to see through the bonnet when it is raised, which is extremely hazardous. This can be a problem particularly for drivers with short backs or where the seat is too low.

EP-A-1186483 discloses pop-up roll bars which may be located behind the seat of a vehicle, particularly a soft-top vehicle which spring into position behind the driver's head in the case of impact. However, they are not able to provide any protection to a windscreen impact from the front and have limited protection against roof crush.

The present inventor has set out to provide a strengthening member for a vehicle for protecting the driver or passengers in the vehicle from rollover roof crush and from penetration of objects through the windscreen.

Accordingly, in a first aspect, the present invention provides a road vehicle comprising at least one strengthening member fixed to a structure of the vehicle, and extending in front of the driver's position, the strengthening member being dimensioned so that it will not prevent the driver seeing an object which is at least 2 m from the front windscreen, when the driver uses binocular vision and without requiring the driver to move the driver's head.

The inventor has realized that the conventional belief that optimum vision can only be obtained if there are no structural components between the driver and the windscreen is not correct. The inventor has realized that a strengthening member can be designed which has minimal visual impact but which significantly enhances the strength of the vehicle, in particular resistance to impacts from the front and roof crush.

The first aspect of the invention also provides a strengthening member for use in a road vehicle, for fixing to a structure of the vehicle, and for extending in front of the driver's position, the strengthening member being dimensioned so that, when in use, it will not prevent the driver seeing an object which is at least 2 m from the front windscreen, when the driver uses binocular vision and without requiring the driver to move the driver's head.

In a conventional road vehicle, the present invention preferably provides at least one strengthening member extending between the front structure of a vehicle and a top frame of the front windscreen.

The strengthening member of the present invention can also be applied to vehicles, which are not constructed in the same way as a normal road vehicle, for example formula racing cars or unconventional energy saving vehicles, which are currently being experimented with. Many of these vehicles have a pod-like curved windscreen which extends around the driver and/or passengers. Where the vehicle has a windscreen, whether in a conventional vehicle or an unconventional vehicle, the strengthening member is preferably fixed to a structure of the vehicle and extending adjacent the front windscreen, the strengthening member extending between lateral edges of the front windscreen. In some racing cars, there is no windscreen at all, in which case the strengthening member can be provided extending in front of the driver's position.

By "in front of the driver" it is meant that the strengthening member is located ahead of the driver's position, along the longitudinal axis of the vehicle, when seen in side view. It is not necessary that the strengthening member is placed directly in front of the driver's position. Many vehicles are designed with a notional centre line. The driver's position is conventionally located to one side of this centre line. In this case, the strengthening member may be located on the centre line, on the same side of the centre line of the driver's position or to the other side. Preferably, it is located substantially on the centre line.

The present inventor has also realized that movable strengthening members can be provided which move from a storage position in which they are not substantially visible to the driver when looking straight ahead, to a reinforcing position extending between structural members of the vehicle. In this aspect of the invention, the reinforcing member is substantially or completely invisible during normal use of the vehicle, being only put into position in the case of an accident.

Accordingly, in the second aspect, the present invention provides a vehicle comprising at least one strengthening member which, in a first, storage position is retracted and in a second, extended position, extends between structures of the vehicle, and operating means for moving the strengthening member from the first position to the second position, wherein if the reinforcing member is for extending adjacent the front windscreen in the extended position, it remains possible for the driver to see through at least part of the front windscreen.

The second aspect of the invention further provides a strengthening structure for mounting in a vehicle, the strengthening structure comprising a strengthening member and operating means for moving the strengthening member from a first, storage position to a second, extended position, the operating means and the strengthening member being configured to engage structures of the vehicle.

One embodiment of the design of strengthening member for use in the first aspect of the invention is considered to be inventive its own right. Accordingly, a third aspect of the inventions provides a strengthening member for mounting in a vehicle, formed of at least two first linearly extending structural units for extending from the front structure of the vehicle and second linearly extending structural units joining the at least two first linearly extending units, the second structural units being not horizontal, and wherein the first linearly

extending structural units of the strengthening member have a width in the horizontal plane not exceeding 65 mm, preferably not exceeding 50 mm.

The horizontal plane is taken to be the plane which will be horizontal when the strengthening member is put in position.

Preferably, in the third aspect of the invention, there are at least three first linearly extending structural units.

In the second and third aspects, the vehicle is preferably a road vehicle. However, the inventions are inherently applicable to all cabin-spaces with occupants of vehicles or vessels, whether static or traveling on road, racetrack, in the air and space, or at sea.

In the first, second and third aspects, the vehicle is preferably a passenger carrying road vehicle.

Preferred features of the first, second and third aspects of the invention will be described below in more detail.

Throughout the present description, reference will be made to conventional passenger motor cars. Conventional passenger motor cars have eight parts which are traditionally thought to have an influence on roof crush resistance:

The outer a-pillar, the outer b-pillar, the side panel, the inner rear reinforcement hinge pillar, the reinforcement lower hinge pillar, the b-pillar, the inner a-pillar, the roof side frame and roof side panel. Reference will be made to these structures throughout where necessary.

First Aspect-Fixed Strengthening Member

Preferably, as noted above, the vehicle has a windscreen and the strengthening member extends adjacent to the front windscreen of the vehicle, extending between lateral edges of the front windscreen.

By "extends adjacent the front windscreen" it is meant that the strengthening member is located either in front of the windscreen or between the driver and the front windscreen. Preferably, the strengthening member is placed either abutting the front windscreen or spaced from it by a small distance, for example in the range 2-20cm, as explained further below.

It is particularly preferred that the reinforcing member is located inside the passenger compartment of the vehicle. This has the particular advantage of being able to arrest the windscreen in the case of a collision, as will be described further below. It also places the strengthening member in a position in which it is less likely to obstruct vision of the offside carriage way of a road.

The strengthening member must be fixed to at least one structure of the vehicle. This may be the front structure of the vehicle or a top frame of the front windscreen. Preferably, as noted above, in a conventional vehicle, the strengthening member extends between and is fixed to the front structure of the vehicle and the top frame of the window. This provides a strong structure and the greatest degree of crush resistance in the case of the rollover.

The strengthening member is optionally removable to be taken out and re-installed manually. The strengthening member may then be securely locked in place, for example with a rapid solid bolt-system/slither, made to suit each individual road-car or motor-sport-car design (easy clip quick-lock/screw-lock bolt system similar to convertible roof fastening mechanisms). Further, the whole windscreen with the strengthening member and optionally two A-pillars may thus be removable, for example for convertibles.

The strengthening member may be integrally formed with at least one of the windscreen, the instrument panel beam or a front exterior structure of the vehicle.

It is noted that, in many vehicles the front windscreen is swept back at a substantial angle to the vertical. This means that the top part of the windscreen and the top frame of the front windscreen are located relatively close to the level of the driver's head. By providing the strengthening member adjacent the top frame of the front windscreen, good support in the case of a rollover can be provided. Additional strengthening members can be provided as discussed further below.

It is possible that the strengthening member should only extend for a part of the length of the front windscreen. Preferably, however, it extends for at least 75% of the length of the front windscreen.

A strengthening member can have structural and deflective safety properties while having an opening, or a partial opening, at some area in front of or below the typical position of the interior rear-view-mirror.

The strengthening member suitably extends in the direction of the front-rear axis of the vehicle. However, it may be slightly inclined with respect to this axis, when seen in top plan view, if appropriate.

Additional strengthening members may be provided extending between the top frame of the front windscreen, along the roof structure to the top frame of the rear windscreen, and/or from the top frame of the rear windscreen to a rear structure of the vehicle. These may be formed continuously with the strengthening member which is placed adjacent the front windscreen. They may be formed of separate components which are then placed extending contiguously with one another. They may be connected by any suitable method, for example bonding, welding, gluing or mechanical fixing.

It is particularly preferred that the present invention provides a strengthening member according to the first aspect of the invention in the form of an arch. It may provide a smoothly curving arch. By "smoothly curving" it is meant that at least one edge of the arch comprises no section in which the radius of curvature is less than 5 mm and preferably not less 10 mm, most preferably not less than 20 mm.

The strengthening member may be built up from a single structural member or a plurality of structural members connected together.

The strengthening member may be made of at least one structural member which, in cross section has a smoothly curving profile on the faces which face into the passenger compartment.

The strengthening member may be made of structural members which, in cross section, are solid or hollow.

In order to allow the strengthening member to be placed adjacent the front windscreen, the three-dimensional configuration of the strengthening member is preferably designed as follows.

The member may become narrower in the direction towards the front of the vehicle. It is parts of the structure which are furthest from the driver which are most likely to interfere with the driver's vision and it is desired to make these as small as possible.

The structure may become narrower from top to bottom, in the direction of the width of the vehicle. This allows parts near the base of the windscreen, which are most likely to obstruct the driver's vision, to be made small whilst providing a strong engagement with other parts of the vehicle at the top. This can be achieved by giving the strengthening member a V shape or Y shape when seen from the front. In side-view, the strengthening member may become narrower from the bottom to top, to provide a rigid strut like structure. Alternatively, it may be substantially the same length in the direction of the vehicle, from top to bottom, as long as this does not interfere with driver's vision.

The strengthening member may, in side view, be swept back from bottom to top, as this is the configuration of windscreens of almost all vehicles.

In one embodiment, the strengthening member has the form of a triangular prism which has been sheared in the vertical plane, or a truncated sheared triangular pyramid.

In all embodiments, the strengthening member is preferably not solid, to further reduce visual obstruction. It may be made of perforated material or webs of solid material surrounding spaces. Alternatively, it may be constructed out of linearly extending structural units combined together to provide a strong structure with minimal visual intrusion.

The strengthening member may be formed of at least two first linearly extending structural units extending from the front structure of the vehicle to the top frame of the front windscreen and second linearly extending structural units joining the at least two first linearly extending structural units. In this case, the second structural units are preferably mounted so that they are not horizontal. This further reduces the tendency to obscure parts of the field of vision of the driver. There may be three of the first linearly extending structural units, each joined to the other two by second structural units. The three linearly extending structural units may be positioned in a triangular arrangement.

A strengthening member can be produced by cutting and folding from one sheet of material into the final shape. Laser-cutting, hydro-forming, welding if required, or any manufacturing technique may be used.

Honeycomb sandwich structure composite materials of any nature may be used for example steel/titaniuml/carbon fibre/KEVLAR™/ plexi/reinforced polyamide 66/Glassfibre-reinforced PP, or any new alloy).

To further minimize visual obstruction, the strengthening member may be configured with a front structural unit and a rear structural unit, the front and rear structural unit lying substantially in line with the normal position of the driver for driving. In this way, although there are two structural members giving strength, only a single unit is seen by the driver when viewed with one eye and visual intrusion is minimized when viewed with both eyes.

Preferably, the first linearly extending structural units of the strengthening member have a width in the horizontal plane not exceeding 65 mm, preferably not exceeding 5 cm, most preferably not exceeding 3.5 cm, to minimize visual obstruction. The first linearly extending structural units of the strengthening member preferably have a width in the horizontal plane which does not exceed the distance between the eyes of the driver. Most drivers have an eye separation falling in the range 5.5-6.5 cm. The width of the structural unit is preferably less than this and preferably less than 65% of minimum normal eye separation. The horizontal plane is taken to be the plane which will be horizontal when the strengthening member is in position in a vehicle in the normal upright configuration of the vehicle.

Preferably, the second structural units have a width in the horizontal plane which is less than 65 mm, preferably less than 50 mm. Preferably, they are not horizontally aligned.

Preferably, the separation between the first linearly extending structural units in the horizontal, plane is at least 65 mm.

If the maximum width of the structural units is equal to 50% of the eye separation of the driver, the driver will be able to see, using at least one eye, any object which is the same distance away from the structural units as the distance from the driver to the structural unit. As the normal distance from the driver to the strengthening member will be less than 1 m, the driver will be able to see objects which are around 1 m or more away from the strengthening member.

It is noted that, where the strengthening member is placed adjacent the front windscreen, for example centrally, it should have a lower visual intrusion than the type of front a-pillar conventionally used. These are typically constructed of solid, visually obstructive material and of a thickness wider in the horizontal-plane than the eye separation of a driver.

In practice, the vision of the driver is considered to be acceptable if not more than 6° of visual field is obstructed by the strengthening member.

The strengthening member is preferably mounted so that it does not contact the front windscreen along the whole length of the strengthening member. Preferably the strengthening member contacts the windscreen for less than 50% preferably less than 40% and preferably less than 20% of its length. Preferably, parts of the windscreen where the strengthening member contacts the windscreen are restricted to upper parts of the windscreen, for example in the area of the centrally mounted rear view mirror. This further reduces visual obstruction.

It also has the benefit of not increasing the stiffness of the lower part of the windscreen, but providing increased ability to absorb impact. In particular, it has been observed that in many types of impact collision with the windscreen, for example during collision with a cyclist or pedestrian, the cyclist or pedestrian frequently contacts the lower part of the windscreen. This in fact is often made head first, causing many fatalities. By providing a space between the strengthening member and the lower part of the windscreen, the lower part of the windscreen is enabled to flex a short distance, absorbing some of the energy of collision. However, it is then arrested by the strengthening member before moving backwards any further, preventing the windscreen or the object striking the driver.

The strengthening member itself may be designed with energy—absorbing properties. In particular, the portion of the strengthening member furthest away from the driver may be made so that it will flex or crumple upon impact, to absorb impact. This is particularly the case where the strengthening member is designed so that it increases in width from front to back, so that the front is relatively lightly constructed. It is desirable to design the strengthening member so that it will deflect for approximately 10-20 cm in case of collision from the front or a rollover preferably 10-12 cm. However, preferably it will not move so far as to endanger the driver.

The strengthening members according to the present invention may be manufactured from cast, pressed, forged or built up structures.

Strengthening members according to the present invention may be finished on the inside, where they face the passenger compartment, with impact absorbing material, for example expanded elastomeric material or padding similar to the upholstery of the interior of a vehicle, and in accordance with legislation relating to vehicle construction.

A strengthening member according to the present invention should extend from at least one fixed structure adjacent a panel or window of the vehicle, for example a frame for a window. This gives it a firm fixing position. Preferably, it extends between structures of the vehicle located on opposite edges of the panel or vehicle, to form a strong bridge between these structures, thereby augmenting the structural strength of the vehicle.

Additional strengthening members may also be provided. At least one strengthening member may be provided in contact with the vehicle roof. This is particularly applicable in hard top/cabriolet cars. The strengthening member may continue spanning the roof as the spread profiles backwards along the central roofline/cover connecting with the roof cross pro-

files between the pillars for additional support. Preferably, the strengthening member contacts the upper rear window frame. Preferably, there is a strengthening member in contact with the rear windscreen along substantially its whole length to the lower end of the rear window area.

When a strengthening member is provided adjacent the roof, this can provide additional reinforcement, for supporting roof box loads. It also provides a possibility of a central longitudinal roof rail for more secure attachment of miscellaneous cargo carrying devices on the roof.

This can provide resistance to impacts against the front windscreen, roof or rear windscreen. The structure can integrate with existing vehicle structures to enhance the total strength of the whole combination. Connection between strengthening members and the rear windscreen or the roof may be of any suitable means, for example, adhesive or mechanical connections. Longitudinal strengthening members may be additionally provided extending for example along the transverse edges of the front windscreen, roof, or rear windscreen. Transverse strengthening members may be provided extending from the a-pillar, b-pillar or c-pillar towards a strengthening member mounted adjacent the front windscreen, roof or rear windscreen as appropriate. This can provide additional rigidity and strength. Further, internal strengthening members extending from the vehicle chassis to the roof or to a strengthening member adjacent to the roof may be provided within the vehicle to provide additional resistance to crushing.

The additional strengthening members may be constructed in the same way as the strengthening member of the invention. For example, for lightness, they are preferably constructed out of light material. Preferably, they are constructed with lightening spaces in their structure. Preferably, they are constructed from a plurality of linearly extending structural units.

In a particularly preferred embodiment, the structural design of the strengthening member of the invention may be applied to the structure of conventional pillars of the vehicle, including the a-pillars, b-pillars or c-pillars. In this way, the visual obstruction to the driver to the sides can be improved.

In particular, these components of the vehicle are preferably each configured so that they do not prevent the driver seeing an object which is at least two meters from the respective structure of the vehicle, and preferably at least one meter from the respective structure of the vehicle, when the driver uses binocular vision and without requiring the driver to move the driver's head.

Each of the a-pillars, b-pillars or c-pillars is preferably not solid, to further reduce visual obstruction. Each may be formed of perforated material or webs of solid material surrounding spaces. They may each be constructed from a linearly extending structural units combined together to provide a strong structure with minimal visual intrusion. They may each be formed of at least two first linearly extending structural units and other linearly extending structural units joining the at least two linearly extending structural units. In this case, the second structural units are preferably mounted so that they are not horizontal. Preferably, structural units of the a-pillar have a width not exceeding 65mm, preferably not exceeding 50mm, most preferably not exceeding 3.5cm, to minimize visual obstruction.

In one preferred embodiment, all of the strengthening member according to the invention adjacent front windscreen, the a-pillars and the b-pillars and, optionally, the c-pillars are formed according to the principles of the constructions of the strengthening member of the invention. Preferably, they are all constructed with lightening spaces in them, being preferably all constructed from a plurality of linearly extending members.

This can give a very open "cage like" structure to the vehicle, with very high degrees of vision to the front, to the sides and, optionally, to the rear as well. High strength for resisting impact can however be provided. If necessary, high strength/low weight materials may be used.

It is noted that the vision in the direction of the c-pillars is probably the least important and these parts can be made of solid structures in the conventional manner, to save costs.

It is an advantage of the present invention that, where a strengthening member is provided adjacent the front windscreen, it may be possible to form the a-pillars of the vehicle in a less bulky fashion than is the current practice. That is, they can be made smaller or they can be made of structures having spaces therein. In this way, good vision to the side can be obtained.

Tens of thousands of fatal accidents a year can be attributed to collisions with objects to the side of a vehicle. The additional strength provided to the centre of the windscreen by the strengthening member of the present invention will allow the a-pillars to be less visually obstructive and to reduce this kind of accident.

The windscreen may also be made wider than is normal. It may be so wide as to be directly adjacent to the side-windows of the doors, when seen from the exterior. The preferred method of securing the position of the windscreen onto the strengthening member and a-pillars is bonding on the outer edge of the strengthening member and a-pillars. A space between these members and the windscreen may be provided in selected places in order to benefit from the laminated windscreens inherent shock cushioning.

To further optimize the field of vision properties during all driving conditions, the windscreen may be formed or coated with a suitable material to reduce glare and dazzle, for example ITS variable electro-photo-chromatic ray screening capabilities to protect the driver from strong sunlight and reflections.

The safety benefit which can be obtained with the present invention include:

- Superior field of vision is possible for all driver/pilots compared to conventional designs
- Rollover roof crush protection
- Deflection protection from windscreen impacts.
- The provision of a physical barrier for external objects (including large mammals pedestrians etc.) penetrating into the passenger cabin through the windscreen, roof or rear window.
- Reduced ejection of driver/passengers in a crash, if they are not wearing seat belts.
- Windscreen support to improve resistance to cracks from stresses and impacts.
- Possible central secure attachment of heavy roof load/slid boxes, allowing an increased carriage of weight.
- Increased reinforcement to windscreen/frame/support-structure with significantly reduced risk of object impact/penetration in collision conditions with rollover impacts at multiple angles.
- Increased confidence of vehicle passengers relating to protection from top impacts, so that they will more readily wear seat belts.

In a preferred embodiment, the driver's seat is located in a fixed position, so that the position of the driver with respect to the strengthening member is substantially fixed. In this case, it will also be preferable that the controls of the vehicle are adjustable. For example, the steering wheel, seat, control

handles and pedals may be adjustable so that they are at the right place for the driver. Such a positional alignment can be implemented automatically by sensors and electro-motors.

Also, or alternatively, the angle of the central strengthening member may be turned around its own axis, for example by a bolt/joint-system, manually or automatically, in order to align in the centre middle between the eyes of the driver, for optimal transparency.

The strengthening member (and, optionally, the a-pillars) may be asymmetrically aligned towards the position of the eyes of the driver for optimized transparency. The angle of the pillars may thus ensure that the material width in the horizontal plane is always significantly less than the width between the drivers' eyes, and most preferably less than 40mm, whilst allowing the structural units to have sufficient thickness to have strength. The space between structural units of the strengthening member should be 65mm or slightly more in the horizontal plane in order to ensure that material does not block the lines of vision as the individual pupils of the eyes are considered to be spaced no more than 65mm.

The present invention may also provide additional benefits including increase in chassis rigidity and torsional stability for improved road handling under load and less tiring road and wind noise, and improved driver alertness due to reduced strain from fear of collision. This can increase resistance to fatigue, better sensory perception, better coordination and better reaction times, due to efficient and rational cognition.

In order to prevent the additional structure provided by the strengthening member from increasing the weight of the vehicle excessively and raising the centre of gravity of the vehicle, it is desired to form it from light but very strong material.

The strengthening member may be formed of any suitable material, including modern light and strong materials such as metals, metal alloys (e.g. boron steel), composites including for example steel/titanium/aluminum/zinc/copper/steel and/or KEVLAR/synthetic-fibre/hyperstructures or other composite materials made using synthetic polymeric materials, or wood/polymeric material composite. Carbon fiber may be used. Transparent contemporary generation strength plastics may be used provided that the structures are aligned such that, with respect to the driver's position, they do not optically distort the driver's perception of the road, nor reflect sun-light unfavourably.

Where an additional strengthening member is mounted adjacent to the roof, it is preferably in contact with the roof to increase the strengthening effect and to reduce physical intrusion into the passenger compartment. This can reduce the danger of impact with passenger's heads and structures of the vehicle. The strengthening member may be provided with an impact-reducing surface on the inside, for example energy absorbing material such as padded upholstery or other resilient surfaces.

The structural elements of the strengthening member are suitably rounded in shape so that no sharp edges are presented which may cause injury to passengers.

A strengthening member according to the present invention may be provided for any suitable type of vehicle, including sports utility vehicles, multipurpose passenger vehicles (MPVs) sports cars, saloon cars/hatch backs, station wagon/estate cars, buses, trucks, people carriers or any other type of vehicle, as well as aircraft, spacecraft, trains or ships

The present invention may be used for conventional designs of vehicle which have a front structure for housing an engine or for providing storage space and a rear structure for providing storage space or housing an engine. However, the invention may be applied to unconventional designs of vehicle in which the front structure of the vehicle comprises part of the vehicle frame. For example, the present invention may also be used in experimental types of vehicle in which machinery is mounted in longitudinally extending frame, the superstructure being built on the frame. The present invention can advantageously provide a strengthening member extending from a front part of such a frame (a front structure of the vehicle) for providing an additional protection behind the very large front windscreen.

The strengthening member of the present invention can be provided at relatively low cost. It can be provided as an additional item for insertion into an existing vehicle. Alternatively, it may be integrated with the vehicle structure during production in a simple, efficient fashion.

The reinforcing member of the present invention may provide a suitable mounting for additional devices, selected from:

1. a centre mounted windscreen wiper, having a high or centre windscreen pivot point;
2. a front windscreen de-mister;
3. a mounting for a rear view mirror;
4. a mounting for small high performance beam lights and/or hazard blinkers;
5. a mounting for instruments or warning lamps for the driver. These may be closer to the visual field of the driver than the dashboard.
6. monitor screens (for example rear view/dead-spot cameras of Siemens/VDO type;
7. sensors of various capacities.

Second Aspect of the Invention-Movable Strengthening Member

As noted above, the second aspect of the invention provides a vehicle with a strengthening member with two positions. The strengthening member is preferably positioned adjacent to the front windscreen in the second position, to resist impact.

The vehicle is suitably a road vehicle, preferably a passenger carrying road vehicle.

The operating means for moving the strengthening member from the first position to the second position may be activated by any suitable means. For example, it may be activated by the driver or by automatic means. Automatic means are preferable, as they may be configured with a much faster reaction time. For example, a detector means may be provided for determining if the vehicle has impacted an object, for example, a large mammal or cyclist or if the vehicle is starting to rotate at a dangerous angle which may lead to rollover. Alternatively, an object sensor may be provided for detecting objects located in front of the vehicle. For example, a short-range radar detector, or thermal detector may be provided configured to detect the spectrum of heat generated by a living body. Any combination of these sensors may be provided.

Suitable sensors are available to the person skilled in the art and they can be set at the correct sensitivity in order to move the strengthening member from the storage position to the first position to the second position under the correct conditions.

The first position may store the strengthening member either inside the passenger compartment of the vehicle, or outside the passenger-carrying compartment. Similarly, the strengthening member may lie inside the passenger compartment of the vehicle or outside it in the second position. Preferably the strengthening member is mounted inside the passenger compartment in the first position. This has the advantage that in the case of a collision, for example caused

by an object striking the windscreen, if the reinforcing member is located within the vehicle, it will have time to react whereas if it were outside the vehicle, it would be too late. However, it may still be positioned outside the range of movement of driver/passengers therefore not producing further hazards.

As noted above in relation to the first aspect of the invention, a combination of a windscreen and a reinforcing member located behind the windscreen can provide a cushioning effect in that if the vehicle strikes a pedestrian, the pedestrian will initially contact the windscreen causing it to flex backwards and reduce the impulse delivered to the pedestrian, the windscreen and pedestrian being arrested by the reinforcing member.

The strengthening member is preferably configured so that, in the second position, it extends between any suitable structures of the vehicle, so that it is supported at both ends, giving a strong structure. The structural members may include windows or panels of the vehicle structure, but it is particularly preferred that the strengthening member should extend between frame components which are relatively rigid. The strengthening member may be mounted so that it moves to a second position in which it extends between the chassis and the roof or between the top structure of the rear windscreen and the rear of the vehicle. This may provide additional resistance to crushing. The strengthening member may be stored in the first position for example behind the seats of the vehicle. Receiving structures may be formed in the roof or along the top structure of the rear window to receive the reinforcing member.

For example, the strengthening member may be mounted so that, in the first position it is mounted behind or within the seat of the driver or the passengers and/or a head rest of the seat, and in the second position locks into to solid supports formed in the roof structure. This can provide direct protection to passenger's or driver's head in case of a roll over.

The operating means for moving the strengthening member from the first position to the second position may be any suitable means, for example, resilient means may be provided. The resilient means may bias the strengthening member from the first position to the second position, movement of the strengthening member being prevented until the means for the moving the strengthening member is activated, for example as described above.

The operating means for moving the strengthening member from the first position to the second position preferably moves the strengthening member very quickly from the first position to the second position. Suitably the strengthening member is moved from the first position to the second position in a time period of less than one second, more preferably less than 0.5 seconds and preferably around 0.1 seconds.

The strengthening member may be moved from the first position to the second position by any suitable type of motion. For example, it may be pivoted about a pivot located near or at an end of the strengthening member.

For example, at least one, preferably 2 and preferably at least 3 or 4 strengthening members may be pivoted centrally adjacent to the front windscreen. At least one strengthening member and preferably at least 2 strengthening members may be provided pivoted at each respective edge of the front windscreen. The pivot may be located on the lower edge or adjacent the upper edge of the windscreen.

The pivoting motion may be driven by a drive acting on the pivot itself or by a linkage acting at a position on the strengthening member displaced from the pivot, for example at the end of the strengthening member.

The strengthening member may be moved into position by extending substantially linearly. For example, it may comprise a telescopic structure having at least one part telescopically moveable with respect to a second part. The strengthening member may comprise a first part and a second part movable along the first part, the movement of the second part being guided by movement of a sliding member formed in one of the first and second parts in a track formed in the other of the second and first parts.

The strengthening member may be moved into position by sliding it into position. It may slide for example from a respective lateral edge of the windscreen. It may slide from the top edge of the windscreen or from the bottom edge of the windscreen.

The extending rollbars disclosing EP-A-1186483 may be adapted for use in the present invention. In order to be used in the present invention, they must be configured so that they extend between structures of the vehicle in the extended position.

The first and second parts may be mounted adjacent the top of the windscreen in the first position or adjacent the bottom of the windscreen of the first position. They may be configured to move to any point to reach the second position. For example, they may be configured to move to respective corners of the windscreen, for example corners opposite to the corner at which the respective parts are located in the first position.

Preferably, the strengthening member comprises a plurality of strengthening member units articulated together and which are moved by a combination of any of rotation, extension, or sliding. In this way, a strengthening pattern can be provided comprising a number of strengthening member units extending over the area of the front windscreen.

Preferably, an engagement member is provided for fixing the strengthening member in position in the second position.

For example, the strengthening member may be configured to move from the first position so that it engages a fixed engagement member and is held in position by the engagement member when in the second position. A locking member which is integral with the strengthening member may be provided, for example being in the form of a toggle lock.

The strengthening member itself is suitably of a shape such that, when in the second position, it does not substantially obstruct the vision of the driver. Preferably, the strengthening member is configured so that, in the second position, it is still possible for the driver to see through at least part of the lower half of the windscreen. This is the part of the windscreen through which the driver normally looks when in the driving seat and it is important that it should be possible to see through it even when the strengthening member has been extended, in the case of an accident.

It is preferable that the strengthening member is dimensioned so that it will not prevent the driver seeing an object which is at least two meters from the windscreen, when the driver uses binocular vision and without requiring the driver to move the driver's head. A balance will be sought between the need to provide a strengthening member which is sufficiently large to be strong with the desire to minimize obstruction of the field of vision. Suitably, the strengthening member will have a width as seen by the driver of less than 5 cm. This can be achieved where a plurality of strengthening members or strengthening member units are provided which together form a protection adjacent the front windscreen.

In a preferred embodiment, the strengthening member may be configured so that it is attached to a web of material which the driver can see, the web of material being drawn across at least part of the front windscreen when the strengthening

member is extended to the second position. This web can be provided in order to catch debris, for example broken glass which can be very hazardous. It may be formed of a mesh or of a transparent or semi-transparent material, so that it does not obstruct the vision of the driver excessively. It may be made of any suitable material, for example a carbon fiber or KEVLARr™ mesh.

In one embodiment of the invention, a strengthening member is provided which is movable between a first position stored in the front of the vehicle windscreen and substantially not visible to the driver and a second position in which it extends adjacent to and in front of the vehicle windscreen. This can be used in combination with a system for raising the bonnet at the same time as the strengthening member is moved from the first position to the second position. The raised bonnet can provide a cushioning effect. The distance by which the bonnet raises may be controlled so that it does not obscure the vision of the driver excessively. If the bonnet is raised in this fashion, it is suitably pivoted at the front and raised at the rear, so that wind resistance does not cause it to tear. The bonnet may be constructed in a conventional way or it may be provided with additional strengthening. It may be ribbed for additional strength. Alternatively, it may be perforated so that it is partly transparent to further reduce impact on the visual field of the driver. It may partly or completely be constructed of transparent material.

The inventor has realized that the increased stiffness provided to the vehicle frame can be used to provide a mounting for an aerofoil extending to the rear of the vehicle. This aerofoil may be integral with the bumper structure of the vehicle. Preferably, the aerofoil is constructed so that air can flow over its top and bottom surfaces in such a way as to generate down force on the rear of the vehicle. This can be valuable when increased road holding is required. For example, this may be required when negotiating tight bends or when braking sharply.

However, an aerofoil constructed in this way can lead to increased air resistance. Accordingly, it is further preferred that closing means be provided which can be used to selectively close the airflow over the top surface of the aerofoil. For example, a shutter may be provided which has a first position in which it does not interfere with airflow over the top of the aerofoil and a second position in which it closes the airflow over the top surface of the aerofoil. Suitably, the shutter in the second position touches the leading edge of the aerofoil, to provide a smooth transition with minimal air resistance. The shutter may slide or rotate into position.

To optimize stability during avoidance maneuvers or cornering, the shutter may be split along the centre line of the vehicle, the split sections being operable independently to the left and right of the line. The split aerofoil may be selectively operable in a cornering mode, in which one is operated differentially with respect to the other, or in a braking mode, in which both sides are operated together. Thus, a down force can be applied on the inside wheels in curves or to equalize the load on both side wheels when braking.

The closing means may be operated by any one of:

A driver operated mechanism

An automatic mechanism. The automatic mechanism may respond to motion sensors which detect the motion of the car (rapid turning, rapid braking), sensors for sensing application of the brake pedal, sudden movements of the steering wheel etc.

This structure is considered to be inventive in its own right and the present invention accordingly further provides a vehicle comprising a rear bumper extending from the rear of the vehicle, the rear bumper being configured as an aerofoil having a top surface and a lower surface, the aerofoil being mounted so that, in at least one position, air can pass over the top surface.

In this aspect of the invention, shutter means are preferably provided for preventing airflow over the top surface.

The first, second and third aspects of the invention may be combined in a vehicle. A vehicle may comprise a strengthening member as defined for the first or second aspect of the invention, as well as a structure according to the second aspect of the invention.

The present invention will be further described with reference to the accompanying drawings in which:

FIG. **1** shows a sketch isometric view of the strengthening member according to the first aspect of the present invention.

FIG. **2** shows the strengthening member of FIG. **1** mounted in a vehicle.

FIG. **3** shows how the strengthening member of the invention can be used to protect the windscreen against collision with large mammals.

FIGS. **4-7** show front or rear views of windscreens including various different embodiments of the strengthening member according to the present invention.

FIG. **8** shows the strengthening member of FIG. **1** constructed in three parts.

FIGS. **9-14** shows schematic cross sections of a number of different types of vehicle incorporating strengthening members according to the present invention and optional internal additional strengthening members.

FIG. **15** shows the effect of the strengthening member of the present invention on the field of vision of the driver.

FIGS. **16-21** show different embodiments of strengthening member placed adjacent a windscreen.

FIG. **22** is a sketch isometric view of a further embodiment of strengthening member for placing adjacent the windscreen, which is also according to the third aspect of the invention.

FIG. **23** shows the effect of the visual field of the driver of the strengthening member of FIG. **22**.

FIGS. **24-25** show embodiments of the vehicle incorporating strengthening members of the present invention.

FIGS. **26***a* and **26***b* show the relationship of the strengthening member of FIG.**22** and new designs of a-pillar in a vehicle.

FIGS. **27** and **28** show further embodiments of vehicle, incorporating a rear mounted aerofoil defining a bumper.

FIGS. **29**A-**29**C show the movement a strengthening member according to the second aspect of the invention from a first position to a second position according to the invention.

FIG. **30** shows a schematic part cross sectional view showing further reinforcing members which may be incorporated in a vehicle.

FIGS. **31-34** shows steps in the movement of a reinforcing member from a first position to a second position according to the invention.

FIGS. **35-37** show an embodiment of a reinforcing member incorporated in the bonnet of a vehicle.

FIGS. **38**A-**38**C show steps in the movement of another embodiment of strengthening member according to the invention from a first position to a second position.

FIG. **39** shows a further embodiment of a strengthening member.

FIGS. **40**A-**40**C, **41**A-**41**C, **42**A-**42**C, **43**A-**43**C, **44**A-**44**C **45**A-**45**C, **46**A-**46**C, **47**A-**47**C, **48**A-**48**C, **49**A-**49**C, **50**A-**50**C, **51**A-**51**C, **52**A-**52**C, **53**A-**53**C and **54**A-**54**C show steps in the movement of various embodiments of

strengthening member according to the invention from a first position to a second position.

FIGS. **55-60** show various embodiments of strengthening member according to the second aspect of the invention.

FIGS. **61** and **62** show further embodiments of pivoting strengthening member according to the second aspect of the invention.

FIGS. **63-74** show various embodiments of strengthening member according to the first aspect of the invention, mounted in a racing car.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** show a first embodiment of strengthening member and a vehicle comprising the strengthening member according to the present invention mounted inside the passenger compartment. A strengthening structure **1** comprises a strengthening member **2** according to the invention which, when assembled, extends adjacent the front windscreen **103** of the vehicle. The strengthening member **2** is connected to a second strengthening member which comprises a pair of ribs **4** which are substantially parallel to one another and which are placed inside and contacting the roof structure **5** of the vehicle. The two ribs **4** come together at a point where they contact a third strengthening member **6** which in use contacts the rear window **7** of the vehicle. The vehicle shown in FIG. **2** is accordingly provided with additional support for each of the windscreen **103**, roof structure **5** and rear windscreen **7**. The support is located between the edges of the structures and directly in contact with them, on the inside whereby considerable support can be obtained. It can be seen that the strengthening member **2** comprises a number of webs with lightening holes, for example **8** as shown in first section **2** in FIG. **1**, to make the structure light and to minimize impact on the driver's field of view. However, with correct design as is well known in the art of the design of girders, beams and other strengthening members, this may have no substantial effect upon the strength of the design.

In FIG. **1**, the different part **2**,**3** and **6** are shown connected together. They may be connected together by a suitable means.

Further, each of the strengthening member **2**, **3** and **6** will be fixed firmly in use onto structural parts of the vehicle, including the section of the front structure adjacent to the dashboard, the top frame on the front window, the top frame of the rear window and the part of the rear structure adjacent to the rear window. They may be fixed using adhesive.

FIG. **3** shows how the strengthening member **1** can provide additional protection in cases of collision with large objects. A collision, even at normal speeds, with an object which is high or large enough to impact the windscreen can result in severe damage to the vehicle and danger to the passengers. For example, the entire roof section may be torn from the vehicle. This kind of hazard can be produced in forested or isolated areas for example, by a large mammal, in the case of FIG. **3**, a moose. It can be seen that in a collision, the animal would contact the windscreen but damage to the vehicle and hazard to the passengers will be minimized by the additional strength given to the windscreen by the strengthening member.

FIGS. **4-7** show various embodiments of strengthening member **1**. FIG. **4** shows a strengthening member which is substantially the same as shown in FIG. **1**. FIG. **5** shows a similar structure but the upper part of the Y is solid, rather than comprising two separate arms.

It is not necessary to have two separate arms if the main part of the strengthening member **2** is sufficiently strong, and a single rib **108** may be used as shown in FIG. **6**.

Alternatively, a pair of substantially parallel ribs **9** may be used as shown in FIG. **7**. Similar structures may be adopted for the third section **6**.

The whole windscreen frame can be manufactured all in one piece from any composite material. The integral structure may comprise any or all of the strengthening member, a pillars and Instrument Panel-beam (IP-beam). The instrument panel and dashboard can thus be integrated only requiring padded interior finish to comply with cushioning shock-absorption directives or feasible design finish preferences.

Such one piece production is considered feasible for a balanced blend of composite materials, as a one piece design may facilitate integrity of strength, and be cost efficient with economy of scale aspects saving assembly time, material consumption and logistics.

FIG. **8** shows a strengthening structure substantially as shown in FIG. **1** but in which the strengthening members **2**, **3** and **6** are constructed separately and subsequently joined together. They may be joined by any suitable means, for example mechanical connections such as bolts, fitted joints or by adhesive or by welding.

FIGS. **9-14** show how different embodiments of the strengthening member of the invention may be provided for various different types of vehicle.

Each of the drawings in FIGS. **10-14** also show optional additional strengthening members extending from the chassis of the vehicle to the roof structure for additional crush resistance.

FIG. **9** shows a soft-top vehicle in which there is only a strengthening member **10**,adjacent the windscreen. All the other vehicles shown in FIGS. **10-14** have hard tops and each comprises a strengthening structure **11** which extends continuously from the front structure to the rear structure, providing support for all of the front windscreen, roof structure and rear windscreen.

FIG. **15** shows the field of view of a driver in a vehicle fitted with a strengthening member according to the present invention. The vehicle shown is a left hand drive type of vehicle. It can be seen that the field of view is still very wide to the driver's right. In fact, the angle of the driver, α, which is restricted in practice by the a-pillar of the vehicle is smaller than the angle β.

In FIG. **16**, the strengthening member **12** comprises a solid filament of transparent material. It can be seen that, along its front edge **13**, it does not abut the windscreen **15** directly. It abuts the windscreen **15** in the section **14**, at the top providing direct support for the windscreen. In practice, it is preferably adhered to the windscreen using conventional high strength adhesive. The lower edge **16** it is fixed to the structure underlying the dashboard.

FIG. **17** shows a different embodiment of the strengthening member **17** which comprises an additional strut **18** which projects rearwardly and contacts the dashboard.

FIG. **18** shows similar design of strengthening member **19** which comprises a lightening hole **20** in a position in which it will not substantially reduce the strength of the structure.

FIG. **19** shows a different design in which a thin filament **21** underlies the top part windscreen, providing support, whilst a substantially vertical section **22** extends upwardly towards the roof providing strong additional support for the roof against rollover roof crush.

FIG. **20** shows an embodiment in which a solid structure **23** is provided with a plurality of lightening holes **24**. FIG. **21**

shows a different embodiment **26** in which the lightening holes **25** are of a different shape.

FIG. **22** is sketch isometric view of a particularly preferred embodiment of strengthening member **27** for use adjacent to the front windscreen of a vehicle.

It is also an embodiment of a strengthening member according to the third aspect of the invention.

It comprises a first longitudinally extending member **28** which is swept back at an angle corresponding to the angle of the windscreen of the vehicle to which it is to fitted. There is a pair of second longitudinally extending units **29** and **30**, which are swept back at the same or substantially the same angle as the first member **28**. They are joined to the first member by struts **31** at the bottom and **32** near the top. The struts **31** and **32** are not horizontal, to minimize visual intrusion. The longitudinally extending members **28**, **29** and **30** join a pair of a v-shaped mounting members **34** and **33** which are for engaging the structure of the vehicle above the windscreen (or the top of the windscreen) and the structure of the vehicle below the windscreen respectively. The top of the v-shaped member **34** is shown hatched to indicate an area where adhesive **35** may be applied to form a bond with the top structure of the vehicle. Alternatively, mechanical connections such as screws and bolts may be used. Similar connecting means may be used in the lower v-shaped part **33**.

Members **28**, **29** and **30** have more than 65 mm open space between them. Members **28**, **29** and **30** are narrower than 65 mm, preferably narrower than 55 mm or 50 mm in the horizontal plane when seen from the drivers' position, and more preferably less than 40 mm. The struts **31** and **32** at their narrowest are narrower than 65 mm and preferably narrower than 50 mm.

This lattice design can be cut and folded from one sheet of material into the final shape. Laser-cutting, hydro-forming, welding if required, or any manufacturing technique may be used.

Honeycomb sandwich structure composite materials of any nature may be used depending on strength/cost requirements (Steel/titanium/KEVLAR™/plexi/reinforced polyamide 66/Glassfibre-reinforced PP, or any new alloy).

The width of each of the longitudinally extending members **28**,**29** and **30** and the struts **32**, **31** presented to the driver does not exceed more than 50% of the minimum normal eye spacing of drivers, being not less than about 3 cm. All of the members are tilted so that they do not form an obstruction to seeing horizontally extending objects. Many objects on the road are either generally vertically extending, such as cyclists, the sides of vehicles, roadside furniture, or horizontally extending for example the super structure of many vehicles. FIG. **23** shows how the obstruction of the driver's field of view is minimized by the structure of FIG. **22**.

The structure **27** is located adjacent to the front windscreen **36** located approximately 1 m from the driver **37**. The width W of the longitudinally extending numbers of the structure **27** presented to the driver are less than 3 cm, so that the area (shown cross hatched) which is not visible to either eye of the driver **37** is minimized. It can be seen that the area which is not visible to the driver extends for a distance of approximately 1 m from the structure. As this distance is less than the normal distance to the front bumper of the vehicle, it is clear that no object which is on the road will be obscured.

FIG. **23** also shows that the a-pillar **38** may be constructed using a similar structure to that shown in FIG. **22** so that the obstruction of vision by the a-pillar is minimized as well

Each a-pillar **38** is most preferably constructed so that it comprises a first longitudinally extending member which is swept back at an angle corresponding to the angle of the windscreen of the vehicle to which it is to be fitted. There may be one or two second longitudinally extending units which are swept back at the same or substantially the same angle as the first member **28**. They are joined to the first member by struts at the bottom and near the top. The struts are not horizontal.

The longitudinally extending members have more than 65 mm open space between them. The longitudinally extending members are narrower than 65 mm, preferably narrower than 50 mm in the horizontal plane width when seen from the drivers' position, or more preferably less than 40 mm.

As for the strengthening member **27**, the a-pillar can be cut and folded from one sheet of material into the final shape. Laser-cutting, hydro-forming, welding if required, or any manufacturing technique may be used.

The whole area of the drivers field of vision subtended by the a-pillar **38** is shown in FIG. **23**. It can be seen that this comprises a central area, lightly hatched, **40** which in practice will be visible to the driver using the design according to FIG. **22**. This area would not be visible using a conventional design of a-pillar. The area, deeply hatched, not visible is clearly very small and does not extend for a significant distance beyond the a-pillar.

As can be seen in FIG. **23**, the relative positions of linearly extending structural units of each of the a-pillars and the strengthening member are adjusted so that at least two line up in the filed of vision to thereby minimize obstruction of the field of view of the driver. As a result, the arrangement is not symmetrical.

The structural units of the strengthening member **27** and the a-pillars **38** are aligned asymmetrically with respect to the centre line of the vehicle, so that they align with the driver's filed of vision to minimize visual impact

The windscreen **36** is made so wide as to be directly adjacent to the side-windows of the doors, when seen from the exterior (wider than most standard cars made in 2005).

Member **38** on the right side of the vehicle, and member **38** on the left side of the vehicle are each bonded to the windscreen which leaves member **27** with some space to the windscreen in order to benefit from the laminated windscreens inherent shock cushioning properties in the event of collisions for example, with pedestrians.

In the a-pillars **38**, one or two of the longitudinally extending members are bonded to the windscreen, the others being spaced from it to provide a shock absorbing capacity.

FIG. **24** shows a schematic side view of a vehicle comprising a plurality of strengthening members. There is a strengthening member **41** according to the present invention adjacent the windscreen and an additional strengthening member **42** adjacent the roof.

The a-pillar **43** is constructed with spaces in it, shown in FIG. **22** to enhance the view forward and to the side as described above. The b-pillars **44**, c-pillars **45** and the rear structure **46** are formed in a conventional manner. However, the inventor has realized that all of these structures may be made of light material with spaces in the structure to enhance the view all round as shown in FIG. **25**. Here there is a strengthening member **47** according to the invention adjacent to the front windscreen, a strengthening member**48** adjacent the roof, a strengthening member **49** adjacent the rear windscreen and perforated structures **50**, **51** and **52** defining the a-, b-, and c-pillars. This creates a very open "cage" through which the driver obtains a clear all round View.

FIGS. **26**A and **26**B show further views of a vehicle incorporating a strengthening member according to FIG. **22** and a-pillars constructed according to the same principles as the structure shown in FIG. **22**.

FIGS. **27** and **28** show views of vehicles corresponding to FIGS. **24**-**25** further incorporating a rear mounted aerofoil **53**.

The rear mounted aerofoil **53** also defines the rear bumper structure. Conventional materials for the rear bumper structure may be provided. However, an upper surface **53**A of the rear mounted aerofoil is configured so that it is spaced from a surface **53**B of the vehicle, to define an airflow passage. This airflow passage is configured so that air flowing under the vehicle is deflected over the top surface of the rear mounted aerofoil. The passage is configured so that a down force may be generated, for pushing the rear of the vehicle more firmly in contact with the road. This can be beneficial for steering and braking.

A dotted line **53**C shows the extended position of a shutter. This shutter may have a first position (not shown) in which it is stored, for example behind the rear wheels of the vehicle, and a second position in which it extends across the opening to the airflow passage formed between the surfaces **53**A and **53**B. In this way, airflow over the top of the aerofoil can be prevented. This allows drag created by the aerofoil to be minimized in conditions where the additional down force on the rear of the vehicle is not required.

The shutter may be divided along the centre line of the vehicle into left and right portions. In a first mode, the left and right portions may be operated together to enhance breaking. In a second control mode, the left and right portions may be independently operable to enhance load on one side of the vehicle, on the inside of a curve during cornering, to improve road holding.

FIGS. **29**A-**29**C show how a strengthening member according to the second aspect of the invention can be moved from a first, storage position adjacent the roof **54** of a vehicle, to a position inside the windscreen **55** of the vehicle when operating means for moving the movable strengthening member **56** are activated. Further details are provided in FIGS. **31**-**34**, which show how the strengthening member **56** slides a long curved path from a storage position adjacent a strengthening member **57** which is adjacent the roof, to a second position in which it lies behind the windscreen **55** and extends between the front structure of the vehicle below the windscreen and the front structure of the vehicle above the windscreen, thereby providing a firmly anchored reinforcement behind the windscreen.

FIG. **29**A and FIG. **29**B can also be descriptive of a static strengthening member according to the first aspect of the invention where the central Alpha-pillar is not entirely connected all the way from the upper windscreen-frame to the lower windscreen-frame/dashboard/instrument-panel-pillar. The strengthening member can have structural and deflective safety properties while having an opening, or a partial opening, at some area in front of or below the typical position of the interior rear-view-mirror.

FIG. **30** shows how an internal fixed engagement structure **58** can be provided which, in the second position engages the bottom of the strengthening member at the point **59** so that a strong resilient structure is provided. For example, the strengthening member may abut the engagement structure or lock into it.

FIGS. **35**-**37** show an embodiment of the second aspect of the invention in which a large object such as a moose **59** is detected by a sensor **60** mounted in the vehicle, so that a moving means described below is actuated. The detection may be for example by short range radar or by a thermal detecting system which is configured to be able to identify the infrared emission of a mammal. The detector may be configured to distinguish the infrared emission of for example an exhaust pipe which is as a relatively high temperature from that of a mammal which is at normal body temperature.

When the object **59** is detected, the bonnet **61** of the car is raised to provide a deflecting structure. However, it is not raised so high that it will interfere with the line of vision of the driver. The windscreen still has to be protected. The windscreen is protected in this case by a further strengthening member **62** which is stored underneath the bonnet **61** in a storage position and which is moved by the moving means to the position shown in FIG. **36** when the object is detected.

The top view shown in FIG. **37** shows that the strengthening member **62** comprises a grid of longitudinal members which are parallel to the direction of motion of the car and horizontal members **63** which are transverse to the direction movement of the car. This forms a across the windscreen for protecting the whole of the windscreen from impact. A strengthening member **64** according to the first aspect of the invention and extending from the front of the vehicle to the rear of the vehicle is provided to provide a further support which the reinforcing member **62** can engage.

FIGS. **38**A-**38**C show a further embodiment of strengthening member according to the second aspect of the invention. The vehicle is shown rolling from a critical position in FIG. **38**A at which a sensor can detect that rollover is inevitable. When this condition is detected, operating means in the form of springs (not shown) are activated to move a strengthening member **65** comprising a plurality of strengthening member units **66** from a storage position in which the sections are stored adjacent the a pillars and the roof of the vehicle. FIG. **38** shows an intermediate position during the movement of the strengthening member units **66** and FIG. **38**C shows the strengthening member in the final position.

Engagement members can be provided for example on the roof structure at the points **67** and on the structure in front of the windscreen at the points **68** which are configured so that they engage the strengthening member **65** when it is in the final position so that it will lock into position. There may be a simple arrangement whereby a part of the strengthening member moves into a position in which it physically engages the engagement member, movement of the strengthening member with respect to the engagement member in the direction of impact being prevented by simple obstruction.

It can be seen that the strengthening member shown in FIGS. **38**A-C comprises a fixed structure **69** in which the telescopic central strengthening member unit **70** is stored. As this is at the top of the windscreen, it does not interfere with the normal vision of the driver.

FIG. **39** shows a corresponding design, except that there is no central telescopic member unit **70**.

FIGS. **40**A-**40**C, **41**A-**41**C, **42**A-**42**C, **43**A-**43**C, **44**A-**44**C, **45**A-**45**C, **46**A-**46**C, **47**A-**47**C, **48**A-**48**C, **49**A-**49**C, **50**A-**50**C, **51**A-**51**C, **52**A-**52**C, **53**A-**53**C, **54**A-**54**C each show further embodiments of strengthening member according to the second aspect of the invention. In each case, the figure designated A shows the vehicle at an angle at which a sensor will detect that rollover is inevitable. At this point, operating means (not shown) which may be the form of a motor, spring loaded drive or any other suitable means, moves a strengthening member. In the position shown in the figure designated C, the strengthening member locks into position adjacent engaging members, which are not shown in detail, to provide a strong support.

In FIG. **40**C, the strengthening member comprises a rigid bar **71** which draws a flexible see-through mesh **72** across the front windscreen, through which the driver can see but which will arrest broken glass and other debris which might strike the driver.

In FIG. **41**C, the strengthening member is provided by strengthening member units which are in the form of articulated arms with sliding pivots **74** which move from a storage position adjacent the edges of the windscreen to a second position shown in FIG. **41**C in which they lock into position behind the windscreen. The sliding pivots **74** may form a toggle lock so that the strengthening member **73** is held rigidly in the position shown FIG. **41**C.

In FIG. **42**C, it can be seen that the strengthening member comprises strengthening member units which slide from storage positions adjacent the screen to define a grid extending across parts of the screen, through which the driver can still see. Similarly, in FIG. **43**C the strengthening member comprises a number of units which extend, slide or pivot into position. Similar comments apply to the remaining embodiments.

In FIGS. **55-57**, various further types of strengthening member are shown. FIG. **48**A-C and **54**A-C show further embodiments of strengthening member according to the second aspect of the invention, in different stages of development. FIG. **58** shows how a plurality of strengthening member units **75** can be provided which pivot upwards from a storage position adjacent the lower edge of a windscreen to which pivot upwards from a storage position adjacent the lower

FIG. **59** shows in more detail a strengthening member according to the second aspect of the invention. The strengthening member is comprised of a number of strengthening member units. There are two linearly extending strengthening member units **76** which are mounted in telescopically loaded mountings **77**. In the storage position (not shown) the strengthening member units **76** do not extend beyond the lower edge of the windscreen and are not visible to the driver. When an impact, approaching object or rollover condition is detected, the strengthening members are released and moved, under the influence of the springs to the second position in which they come to rest in corners of the windscreen where they engage against parts of the frame in which the windscreen is held so that movement of the extended strengthening member units into the vehicle is prevented.

There is a further strengthening member unit **78** which comprises a three component telescopically extending unit. In the storage position (not shown) it is mounted in a spring load storage means **79**. When a crash, approaching object or rollover is detected, the strengthening member unit **78** is released and, under influence of the spring, extends upwardly until it engages a structure **79** which holds it so that movement back into the passenger compartment is prevented. In this way, a strong structure is established across most of the windscreen.

In FIG. **60**, a strengthening member is shown which comprises two strengthening member units **80**. Each strengthening member unit **80** comprises an arm having two arm sections **81**, **82** which are hinged in the middle at a hinge **83**. The free end of each arm **82** is pivoted adjacent a lower edge of the windscreen at **84**. The free end of the other arm **81** is mounted on a slider **85**. The slider is acted against by a spring **86**. The spring is held in a spring housing **87** which itself is pivoted at the bottom **88**. In the storage position (not shown) each slider **85** is held near the base of the unit **87** so that the spring **86** is tightly compressed. In this position, each arm **82** comes to rest adjacent the lower edge of the windscreen but not visible to the driver. When an impact, rollover or approaching object is detected, an actuator releases each slider **85** so that it moves very quickly along the unit **87** to the top, raising each arm **82** and **81** so that a brace structure is formed adjacent the windscreen for resisting impacts. In the second position, the top parts of the arms **82** each come to rest in engaging means **89** which hold them so that movement in the longitudinal direction of the vehicle is resisted.

FIG. **61** shows a further embodiment of strengthening member according to the second aspect of the invention. In this case, pivoting strengthening members **90** are moved from a first position in which they lie adjacent to the front windscreen but below the level thereof, upwards to a second, reinforcing position by operating means in the form of a common spring **91**.

FIG. **62** shows a variation of this design in which the pivot points **92** of pivoting strengthening members **93** are located further apart than shown in FIG. **61**.

FIGS. **63-74** show various embodiments of strengthening member according to the first aspect of the invention, mounted in a racing car. In each case, a fixed strengthening member is mounted in front of the driver and is configured so that it will not substantially interfere with the field of vision of the driver. Further, it is mounted in each case so that it does not substantially interfere with airflow entering the intake for the engine/cooler at the rear of the vehicle.

FIGS. **63**, **64** and **65** show various views of a first embodiment, in which a narrow, longitudinally extending web **94** at the front of the member protects the driver from impact from objects to the front. It is supported at the rear by narrow lateral members .**95**

FIGS. **66**, **67** and **67** show views from different directions of a second embodiment of reinforcing member according to the first aspect of the invention applied to a racing car. It simply comprises an upstanding strengthening member **96** extending from front to rear of the vehicle. A lightening hole **97** is formed at the bottom to reduce the weight while allowing a strong, arched structure to be formed.

FIGS. **69** and **70** show a further embodiment of strengthening member **97** which is similar to that shown in FIGS. **63-65**. Similarly, FIGS. **71** and **72** show a fourth embodiment of strengthening member **98** which is similar to that shown in FIGS. **63-65**.

The strengthening members of FIGS. **63**, **64**, **65**, **66**, **67** and **68** may be made static, according to the first aspect of the invention and as seen in the drawings, or as an active pop-out dynamic system according to the second aspect of the invention. They may be pre-tensioned, or activated by other means. They may be triggered by micro chipped sensor systems similar to all systems for FIG. **29** through to FIG. **62**.

FIGS. **73** and **74** show a strengthening member which has two forwardly mounted strengthening member units **99** which are connected at the rear to a lateral arch member **100**.

Strengthening members and strengthening structures described individually above may be combined in any suitable configurations in a vehicle.

For example, a dynamic pop-out protective curtain as shown in FIGS. **40**A, **40**B and **40**C may be used in combination with the strengthening member of FIGS. **26**A and **26**B. They may be used in combination with air-bags on the outside and/or inside of the windscreen.

The present invention has been described above by way of example only and modification can be made within the invention, which extends to equivalents of the features described. The invention also consists in any individual features described or implicit herein or shown or implicit in the drawings or any combination of any such features or any generalization of any such features or combinations.

The invention claimed is:

1. A strengthening member for use in a road vehicle, for fixing to a structure of the vehicle, and for extending in front of the driver's position, the strengthening member being

dimensioned so that, when in use, the strengthening member will not prevent the driver from seeing an object which is at least 2 m from the front windscreen, when the driver uses binocular vision and without requiring the driver to move the driver's head, wherein the strengthening member has the form of a triangular prism which has been sheared in a vertical plane or the form of a truncated sheared triangular pyramid.

2. A strengthening member for mounting in a vehicle, formed of at least three first linearly extending structural units placed in a triangular arrangemeent, for extending from the front structure of the vehicle and second linearly extending structural unit joining the at least three first linearly extending units, the second structural units being not horizontal, and wherein the first linearly extending structural units of the strengthening member have a width not exceeding 65 mm, the strengthening member having a connection for fixing the strengthening member to the vehicle, whereby, when mounted in the vehicle, the strengthening member extends obliquely to the vertical direction of the vehicle.

3. The strengthening member according to claim **2** wherein the strengthening member is an a-pillar.

4. A road vehicle comprising at least one strengthening member fixed to a structure of the vehicle and extending in front of the driver's position, wherein the strengthening member is dimensioned so that the strengthening member will not prevent the driver from seeing an object which is at least two meters from the front windscreen, when the driver uses binocular vision and without requiring the driver to move the driver's head, wherein the strengthening member has the form of a triangular prism which has been sheared in a vertical plane or a truncated sheared triangular pyramid.

5. The road vehicle according to claim **4**, wherein the strengthening member is mounted within the passenger-carrying compartment of the road vehicle.

6. The road vehicle according to claim **4**, wherein the strengthening member extends between the front structure of the vehicle and a top frame of the front windscreen.

7. The road vehicle according to claim **4**, wherein the strengthening member does not contact the front windscreen along the whole length of the strengthening member

8. The road vehicle according to claim **4**, wherein the strengthening member is formed of three first linearly extending structural units extending from the front structure of the vehicle to the top frame of the front windscreen and second linearly extending structural unit joining the three first linearly extending units.

9. The road vehicle according to claim **8**, wherein the second structural units are not horizontal.

10. The road vehicle according to claim **8**, wherein the first linearly extending structural units of the strengthening member have a width not exceeding 65 mm.

11. A road vehicle comprising at least one strengthening member fixed to a structure of the vehicle and extending in front of the driver's position, wherein the strengthening member is dimensioned so that the strengthening member will not prevent the driver seeing an object which is at least two meters from the front windscreen, when the driver uses binocular vision and without requiring the driver to the move the driver's head, wherein the strengthening member is formed of at least three first linearly extending structural units, extending from the front structure of the vehicle to the top frame of the front windscreen and at least two second linearly extending structural units joining the at least three first linearly extending units, at least two of the first linearly extending structural units lying substantially in line with the normal position of the driver.

* * * * *